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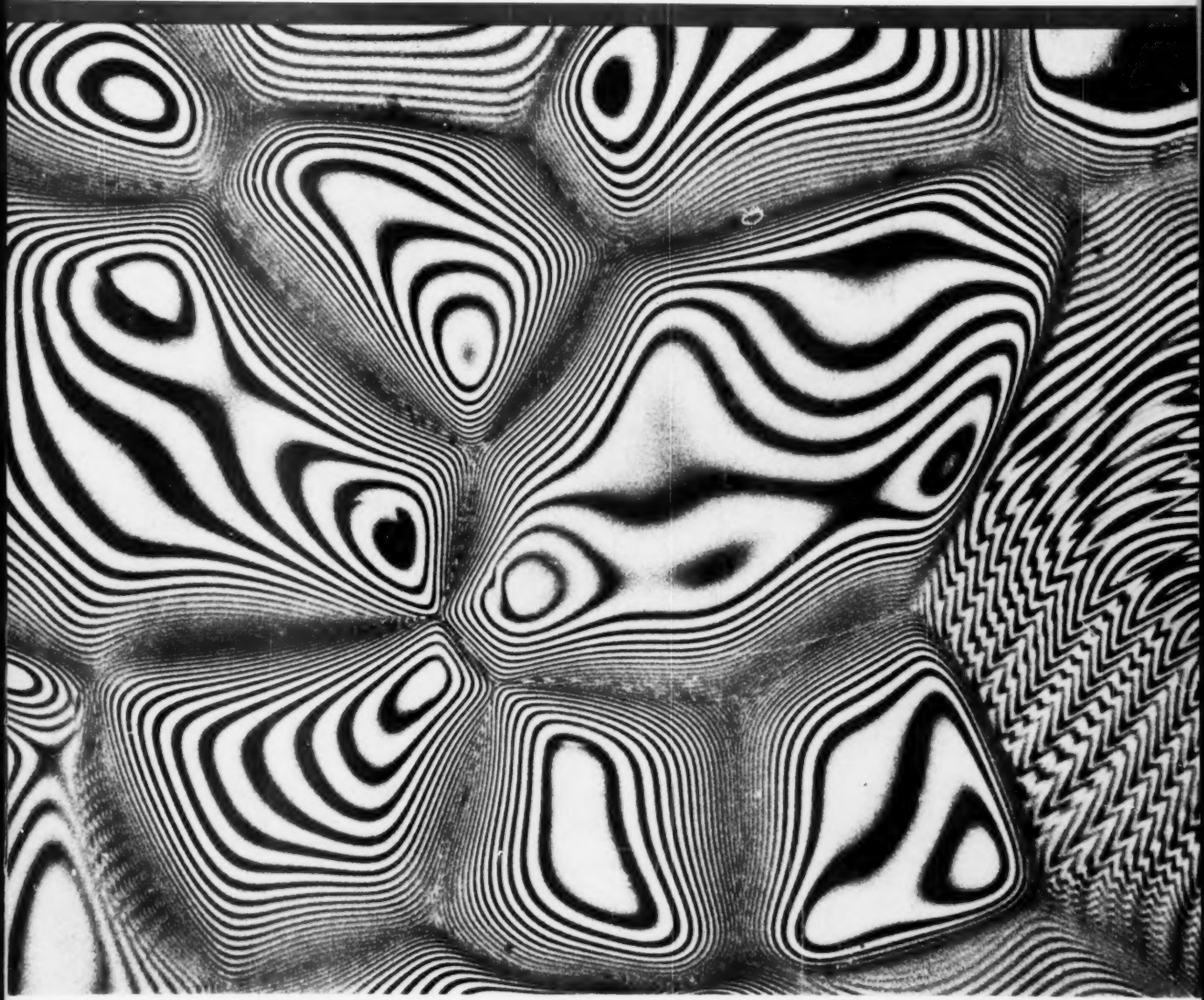
Materials Research & Standards

Bulletin of AMERICAN SOCIETY FOR TESTING MATERIALS



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$$ST_0/RTa_T = \int_{-\infty}^{\infty} M(\tau)\tau(1-e^{-\tau/RTa_T})\,d\ln\tau$$

.....OR HOW TO PREDICT VISCOELASTIC BEHAVIOR FROM SIMPLE STRESS-STRAIN DATA

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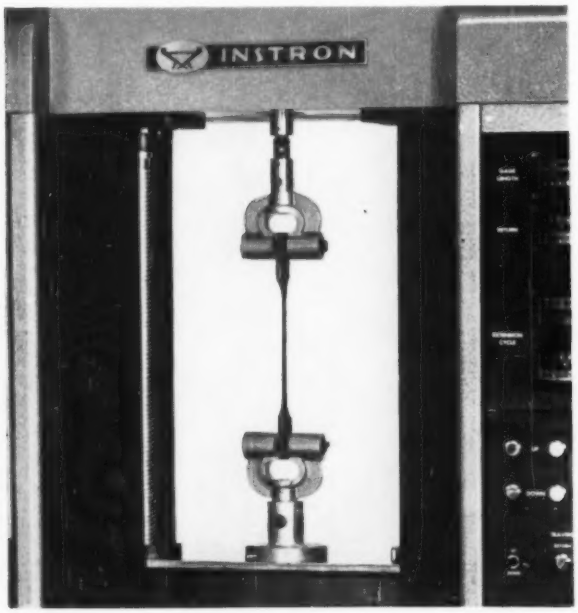

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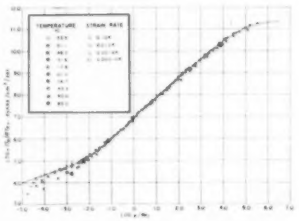
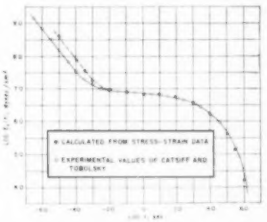


Stress-strain data reduced to unit strain rate at 298°K.



Stress-relaxation modulus derived from stress-strain data compared with experimental data of Catsiff and Tobolsky.

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How the formula was used: Samples of synthetic, non-crossed linked rubber were tested at 10 temperatures between −54° and 85°C, and at constant strain rates between 0.014 and 0.104 x 10^{-1} sec^{-1} on the Instron Universal Tester. Stress-strain data were reduced mathematically to unit strain rate to yield a single curve for each temperature. Curves were then superposed to determine temperature dependence of viscosity, then all data up to 100% elongation were reduced to a single stress-strain curve accurately predicting viscoelastic behavior over nine decades of reduced time. It was shown that stress-relaxation modulus could be calculated satisfactorily from the reduced stress-strain curve.

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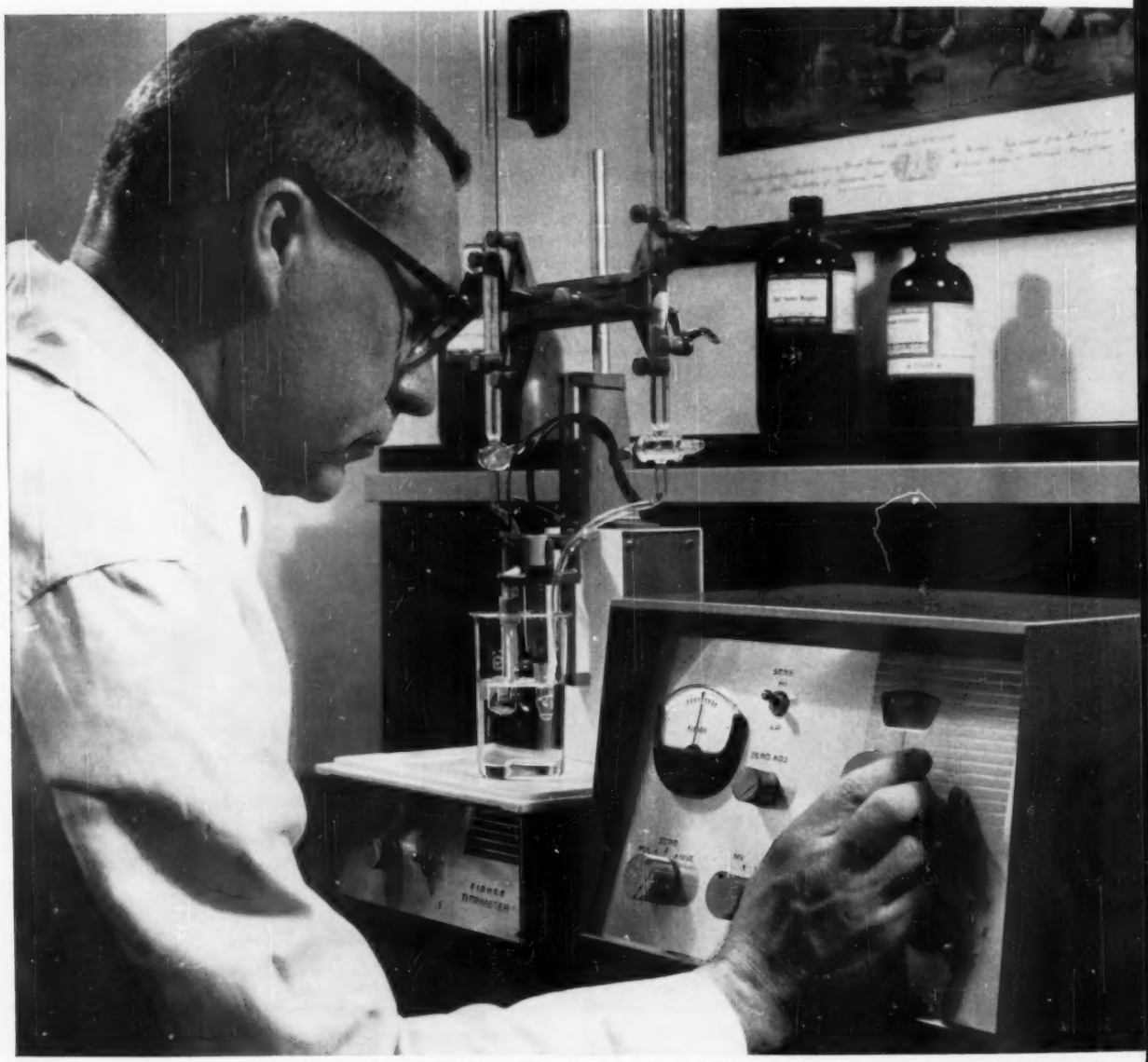

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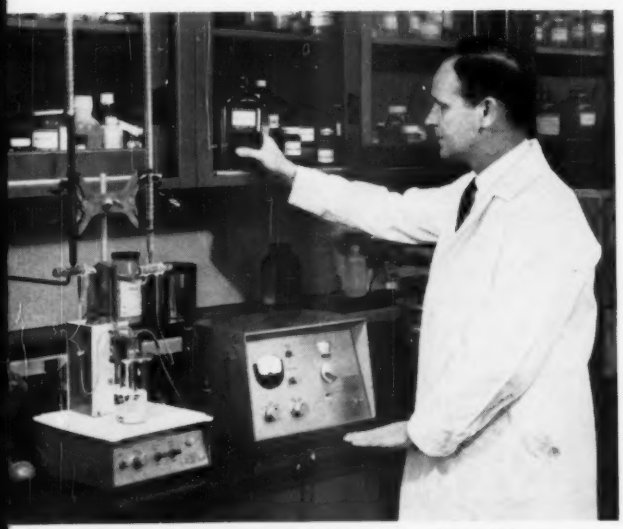

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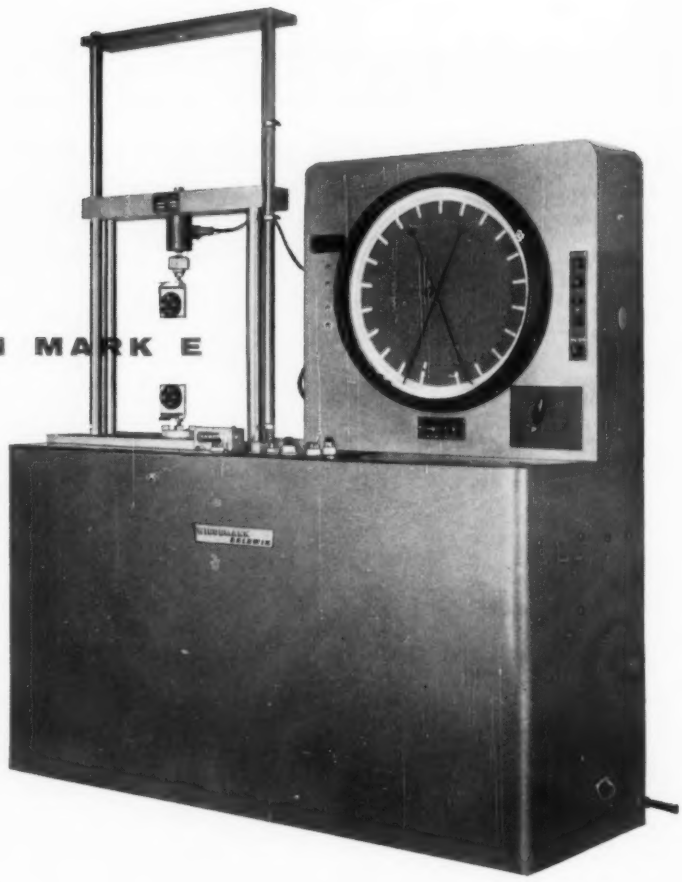

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In This Issue...

- **Test methods for wool,** a material nearly as old as man himself, have been put on a scientific basis only in recent years, largely through the efforts of ASTM Committee D-13 on Textile Materials. The extensive research that underlies present-day testing and sampling procedures for wool is reviewed by some of the pioneers in the field 167

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COVER PHOTO:

Interferogram of the surface of thermally etched polycrystalline aluminum oxide (×1000). Twelfth ASTM Photographic Exhibit. C. C. Hartelius, General Electric Co., Schenectady, N. Y.

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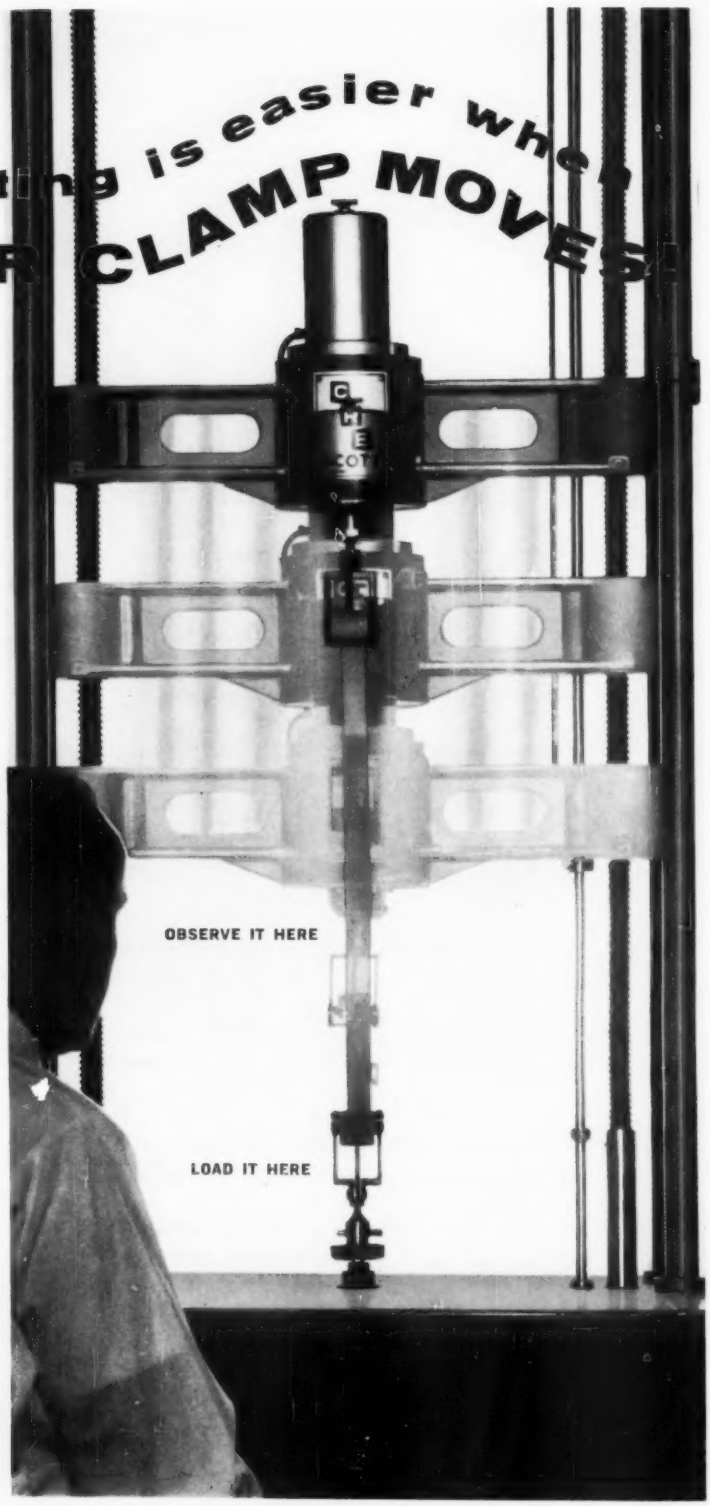

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Materials
Research & Standards

Volume 1, Number 3, March, 1961

Scientific Methods of Wool Testing—A Model for the Textile Industry

NOTE.—Reprints of "Scientific Methods of Wool Testing," which include this introduction plus the three papers following, are available from ASTM Headquarters. Prices on request.

Introduction

The three papers following this introduction cover the assessment of quality, sampling methods, and recent developments in test methods for wool.

By JACKSON BAUER[1]

Over the years Subcommittee A-3 on Wool Fibers, of ASTM Committee D-13 on Textile Materials, has pioneered in standardizing methods of testing and sampling procedures for wool that today are used world-wide. It was decided to present some of the details of these extensive investigative studies in a Symposium on Scientific Methods of Wool Testing—a Model for the Textile Industry which was held on March 20, 1958, in connection with the meeting of Committee D-13.

The individuals selected to present these papers have distinguished themselves in the development of test methods for wool through years of research and practical application of the methods involved.

Research in test methods for wool has reached a point of recognition and acceptance by the wool industry only in recent years. Since wool is a fiber known and used by man from the ages of antiquity, it was only reasonable for many manufacturers in this industry to assume that the scientific method has little place in an industry so completely dependent upon art and "practical know-how and experience." Today, the industry is operating on a new level. Millions of dollars worth of wool is bought and sold annually with the yields based on scientific methods of core sampling and core testing. Similar values in wool top is being determined through scientific testing for wool fineness. The manufacturing processes of wool are accomplished more efficiently and with results heretofore unattainable, thanks to the new test methods for the rapid assessment of wool quality. A more complete knowledge of tests for wool damage has resulted in the concept of modified wool by chemical processes to obtain functional end uses necessary to meet the demands of a changing textile world.

WOOL CORING

Twelfth ASTM Photographic Exhibit. D. R. Condon, United States Testing Co., Inc., Hoboken, N. J.

[1] Director of Research, Automotive Division, Collins and Aikman Corp., Albermarle N. C.

The Assessment of Wool Quality

By E. M. POHLE

FROM TIME immemorial wool has been important in mankind's individual and collective economy. Produced in many areas of the world and under various climatic and environmental conditions, the wools of the world nonetheless have many properties in common. However, there are also many variations, not only in the production of the various countries, but in the individual clips, fleeces, and fibers. Systems of classification, often identical in some respects, differ in application according to regional, local, or individual influences. Commerce in wool would be facilitated through greater uniformity in expression and interpretation of terms used in wool classification.

Wool research has expanded greatly in many countries. Industrial and institutional investigators have contributed much to the knowledge and performance of the wool fiber. Through their efforts technological advances have resulted and descriptive terms scarcely known a relatively few years ago have become a part of the usual trade terminology. One of the leading exponents and coordinators of the scientific approach has been the ASTM, and in the field of wool this has been mainly Subcommittee A-3 on Wool Fibers of Committee D-13 on Textile materials.

Fineness Test Methods and Specifications for Wool and Wool Top

Of the many objectives toward which Subcommittee A-3 has been working, the assessment of the fineness of the fiber is of primary importance. Whether considered in the preparation of wool for market, in grade classification, in production, or in manufacture, fiber fineness has received attention for many years.

Early attempts at classifying wool and wool tops were through visual or subjective means based on training and experience. Such procedures were used in the development of this country's first official standards for grades of raw greasy wool. These standards, embracing but seven grades, were established by the Secretary of Agriculture in 1923, after much investigative and correlative work between the marketing agency of the Federal government and the wool industry. In 1926, after further consultations with the industry here and abroad, the seven grade standards were refined, and a standard series of 12 official grades, from 80's to 36's, was promulgated. At the same time, companion standards for wool top were established. The basis for these two series of standards was fineness or diameter of fiber, grades being represented through samples selected to show the limiting fineness of each grade.

Task groups of Subcommittee A-3 were first organized for cooperative wool measurement work among industry, government, and commercial laboratories during the latter part of the 1920's and early 1930's. After extensive studies and interlaboratory tests, Tentative Methods of Test for Fineness of Wool (D 419)[1] were issued in 1935. Later, specifications for a series of 8 grades of wool top were evolved; these were published jointly in 1937 by the industry and by the Society as part of the Specifications and Methods of Test for Wool Tops (D 472).[2] After further study and numerous interlaboratory tests and continued checking with various segments of the industry, the top specifications and methods of measurement were further revised. In this revision D 472 in 1956, the fineness specifications were extended to cover 14 grades, from 80's (or fine) to 36's (or coarse).

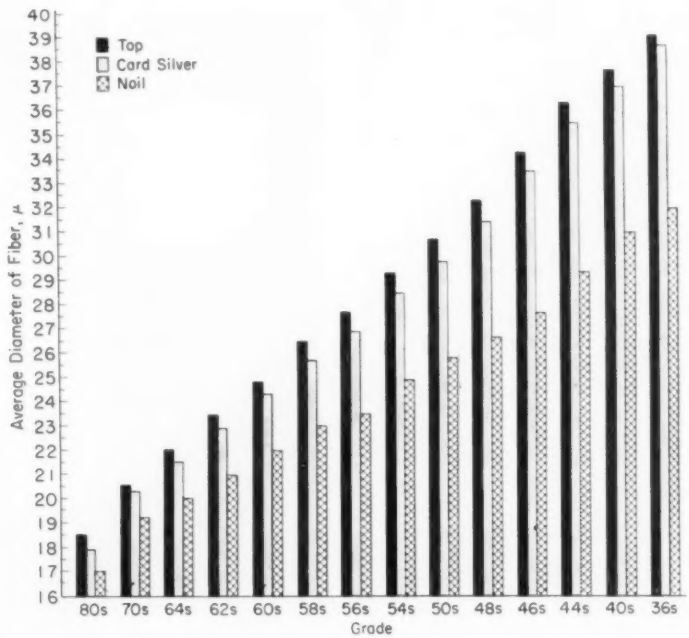

Fig. 1.—Average fineness of top, card sliver, and noil by grade.

ELROY M. POHLE received his B.S. in agriculture from Wyoming University in 1932, and in 1937, a master's degree in wool and fiber technology from the same university. He was in charge of the wool research program of the USDA Western Sheep Breeding Laboratory at Dubois, Idaho, from 1938 to 1947. He has been in charge of the USDA wool grades and standards program in Washington, D. C., and later in Denver, Colo., since 1947. He is presently in charge, USDA Livestock Division Wool Laboratory, Standardization Branch, in Denver, Colo.

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author or authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] 1958 Book of ASTM Standards, Part 10, p. 188.
[2] *Ibid.*, p. 221.

Accompanying the new grade specifications was a revision of the methods of test, incorporating the latest advancements in the field of fiber technology. The specifications and methods of test in Specifications D 472 correspond to the official top standards and methods of test promulgated by the U. S. Department of Agriculture, effective January 1, 1955. They are used by state and Federal government procurement agencies, the Top Exchange, and the industry in general.

The many studies and interlaboratory tests on wool conducted in recent years have covered numerous aspects, such as application of statistical design to sampling, preparation of samples for testing, testing instruments and devices, calibration, number of tests, calculation and interpretation of results, etc. All these have contributed much to improved sampling and testing methods, closer control, and a better understanding in general of the methodologies and principles involved.

In a major study not long ago the Department of Agriculture sought to show how the fiber fineness of wool compares during the various stages of processing from the grease wool (represented by card sliver) to the finished top (1).[2] This relationship is presented in Fig. 1. In this undertaking, embracing wools of domestic and foreign origin, cooperation was liberally extended by members of Subcommittee A-3 representing 19 establishments in the industry.

Figure 2 is a scatter diagram with a regression line showing the fineness relationship of wool top and raw wool. Equations were developed from these data whereby the expected fineness of top can be estimated from the fineness of the raw wool, using the simple linear regression equation:

$$Y_c = 0.1921 + 1.0171X$$

where:

Y_c = fineness of wool top, and
X = fineness of raw wool.

Conversely, the average fineness of raw wool needed to produce a top of a given fineness may be calculated as follows:

$$X = 0.0442 + 0.9747Y_c$$

where:

X = fineness of raw wool, and
Y_c = fineness of wool top.

The first phase of the wool-to-top project consisted of the study of samples obtained from mills. Later the Department of Agriculture arranged for the processing in several plants of nearly a million pounds of wool. By pooling the information from these studies which covered approximately 200 lots, specifications were developed for average diameter and fineness distribution for raw wool, grades 80's to 36's inclusive (2). The ASTM was reviewed and its acceptance recommended. Although immediate international concord can hardly be expected, the interchange may be viewed as progress in the direction of international standards for use in commerce and industry.

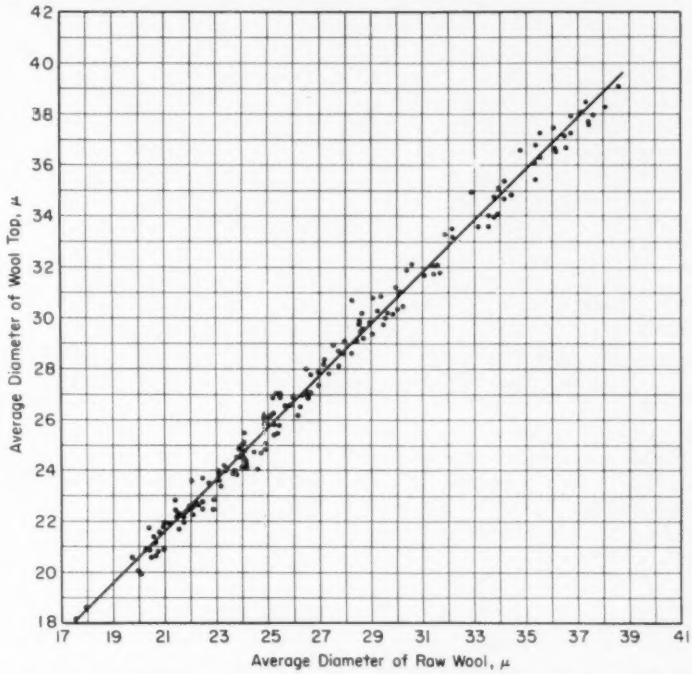

Fig. 2.—Scatter diagram and regression line showing the fineness relationship of wool top and raw wool.

accepted these proposed raw wool specifications and incorporated them in a revision of Methods D 419, in 1955. The application of the proposed fineness specifications in grade placement, based on measurement results for grease wool, by lot, is presented in publications of the U. S. Department of Agriculture released in 1957 and 1958 (3) and (4).

Importance of Wool Fineness in Fabrics

For several years, as time and material have permitted, the wool fineness task group has been conducting interlaboratory studies to investigate what changes, if any, take place in the wool fiber diameter during the processing of the raw wool into yarn and fabric, in both the worsted and woolen systems.

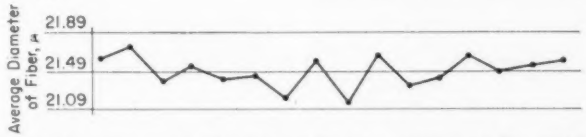

Fig. 3.—Control chart: average diameter of fiber in microns, lot No. 58-27, as determined in interlaboratory tests.

International Studies

In 1957, the Society received from the International Standards Organization a document entitled "Determination of Wool Fiber Diameter by the Projection Microscope Method." The method was essentially the same as the ASTM procedure, and like it represented several years of work. Some years earlier, in 1949, the Indian Standards Institution issued its Standard Specification for Grading of Wool for Export 677.313 (083.75) (54) which included a Method for Determination of Yield. This draft

Several such studies have been completed, and others are planned. These may determine the feasibility of developing specifications for wool fineness in fabrics.

Fineness Measurement Reference Standard

An important piece of work of Subcommittee A-3 has been directed toward the selection of a wool top for fineness measurement reference purposes. In an interlaboratory test, participated in by 16 laboratories, results were obtained which indicated that the top under consideration, lot No.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

58-27, was suitable. General averages for this top, a 64's, were:

Average diameter	21.49 μ
Standard deviation	5.00 μ
Coefficient of variation	23.28 per cent
Distribution:	
10.0 to 20 μ	42.05 per cent
20.0 to 30 μ	52.31 per cent
30.1 μ and over	5.84 per cent
40.1 μ and over	0.36 per cent

As shown in Fig. 3 there was good agreement between laboratories, all values for average diameter of fiber coming within the control limits of ±2 standard errors of the mean.

The purpose of the measurement reference top is to provide a means for the calibration of instruments, the checking of operators, and the unification of the measurement procedure.

Measuring Instruments

Several general types of instruments are available in this country for measuring fineness. The microprojector, involving microscopic optics, has long been in use. This instrument may be used for direct longitudinal and cross-sectional measurement of fibers, or in conjunction with a comparator film strip (of graded specimens in cross-section) for analysis of other specimens by comparison of cross-section patterns. Adaptations of the microscopic techniques are the only means in current use by which fiber fineness distribution as well as the fineness average may be obtained. Of more recent adoption is the basis of the air-flow type apparatus. One of these, the Micronaire, has been the basis of a method of test for wool top for several years. A wool scale was added for this instrument in 1956, thus making the Tentative Method of Test for Average Fiber Diameter of Wool Tops, Card Sliver, and Scoured Wool by Micronaire Method (D 1282)[4] available for both wool and wool top.

Another air-flow instrument recently introduced for determining average fiber fineness is the Port-Ar. This instrument was shown to the wool group at the spring meeting of Committee D-13 in 1958.

The British have recently proposed a Tentative Textile Standard No. 51, 1958, "Determination of Wool Fiber Fineness by the Air-Flow Method."[5] The British instrument is similar to the Micronaire, except that a current of air is drawn through the specimen instead of forced through it as in the American version.

Mohair Tops

Within the scope of the committee's work are those animal fibers closely allied to wool. Through the cooperation of the trade, the task group has developed Specifications and Methods of Test for Fineness of Mohair Tops (D 1381),[6] which cover specifications for eight grades—40's, 36's, 32's, 30's, 28's, 26's, 22's, and 18's, together with test procedures. Another grade, 24's, may be added.

Cashmere

During the 1958 spring meeting of Subcommittee A-3, in response to trade inquiries and requests a committee was appointed to work on definitions and test methods for fiber diameter, specifications, and standards for cashmere.

Other Parameters for Assessment of Wool Quality

Length

In large measure, length of fiber is a determinant of the end product. In general the longer wools of a grade are more advantageously processed on the worsted system and the shorter wools on the woolen. The ASTM long ago recognized this and has had available since 1938 its Method of Test for Fiber Length of Wool Tops (D 519).[7] Through the use of a multiple-comb apparatus, as described in the test method, the average fiber length of wool top and length by $\frac{1}{2}$-in. increments may readily be determined.

Length of staple in raw wool, formerly estimated by a rule-of-thumb procedure, is now determinable by the ASTM Method of Sampling and Testing Staple Length of Wool in the Grease (D 1234).[8] Developed with the assistance of members of the trade, together with personnel of the Department of Agriculture and of agricultural colleges, the method establishes the length of the staple in its normal or unstretched state. Processing studies have shown that a high correlation exists between the average length of the normal or unstretched staples of a wool, as determined by this method, and the average fiber length of top made from that wool (**3,5**).

Although the ASTM Method of Test for Fiber Length of Wool Tops (D 519) does not embrace length specifications for wool tops, length requirements for tops are specified by the Wool Associates of the New York Cotton Exchange, Inc., for various grades and types from 80's through 58's. Length determinations of wool top for Exchange purposes, while based on Exchange standards, are made according to ASTM Method D 519.

In the trading of raw wool on the Exchange, average stretched length requirements for the various grades serve as the guides, along with other quality characteristics, for valuation purposes. However, on the basis of studies of numerous lots of wool, it is felt that the unstretched staple has significance and should be acceptable in estimating the staple length of raw wool. Accordingly, for market classification purposes, length guides, based on the unstretched length, have been suggested by the U. S. Department of Agriculture (**6**).

Table I presents data showing the repeatability for length determination through proper application of the ASTM Method of Sampling and Testing Staple Length of Wool in the Grease (D 1234). A complete statistical analysis of data leading to the development of sampling schedules for raw wool is set forth in reference (**7**).

In another phase of fiber length work, the wool task group developed the Tentative Method of Test for Fiber Length of Wool (D 1575)[9] other than top. This method is designed for estimating fiber length of wool in assemblies, such as scoured wool or card sliver. In combination, the scope of the length methods would therefore make length determination possible whether the wool be in the grease state or scoured, or in the card sliver or top sliver form.

A transparent grid length method,

TABLE I.—COMPARISON OF AVERAGE UNSTRETCHED LENGTH IN INCHES OF GREASE WOOL STAPLES DRAWN FROM X-LOT AND Y-LOT PORTIONS OF THE SAME ORIGINAL LOT.

Original Lot Number	Average Unstretched Length of Duplicate Lot Staples Drawn From		Difference In Average Length	t^a
	X-lot	Y-lot		
5195	2.88	2.87	0.01	0.16
748	2.55	2.48	0.07	1.20
722½	2.85	2.96	0.11	1.52
5074	2.96	2.97	0.01	0.14
4837	3.37	3.28	0.09	1.02
39045	3.26	3.20	0.06	0.68
58003	3.15	3.14	0.01	0.12
5034	3.66	3.62	0.04	0.41
29002	4.10	3.98	0.12	1.09

[a] A "t" value of 1.96 is significant at the 5 per cent probability level.

[4] 1958 Book of ASTM Standards, Part 10, p. 473.
[5] *Journal*, The Textile Inst., Vol. 49, No. 7, July, 1958.
[6] *Ibid.*, p. 556.
[7] *Ibid.*, p. 228.
[8] *Ibid.*, p. 460.
[9] *Ibid.*, p. 685.

a rapid procedure developed commercially showing a length diagram of a wool top, is currently under study by the Wool Length Task Group. This method should be useful for routine checking in the mill.

Strength

Strength of fiber is another property of wool to which task groups have given much study. These studies led to the development of the Method of Test for Tensile Strength of Wool Fiber Bundles (D 1294).[10]

Crimp

Crimp in wool, seen superficially, is the natural wave along the fiber or staple. Attempts are being made through processing and utilization research to learn more about the effects of wool fiber crimp on yarn behavior, performance, and fabric quality.

A task group on crimp in wool was formed in Subcommittee A-3 in March, 1957. After review of available information, a method for determining crimp wave frequency and crimp type was adopted and an interlaboratory test on samples undertaken.

Neps, Slubs, and Vegetable Matter

A task group has, since 1954, been actively studying definitions and test methods for the presence of neps, slubs, vegetable matter, colored fibers, and kemp fibers in card sliver and top. Interlaboratory tests have been held and a proposed method for test for neps in wool tops[11] is under consideration. This method covers the determination of the number and size of neps or small aggregates of tightly entangled wool fibers which retain their identity even upon removal from the sliver or top (Fig. 4).

Moisture

Moisture in wool is an important consideration. Other aspects of the problem and other methods of moisture determination are being investigated.

Color

A factor of importance in wool is color. Besides the distinct departures from white, such as black and brown, resulting from major pigmentation, there are shades of yellowness and grayness which materially affect wool appearance. A task group has been appointed which in its initial studies has been using a color comparator developed by the Department of Agriculture for domestic apparel wools. In wools of the carpet type, color is likewise important, and the development and employment of means for determining and evaluating color in such wools will necessitate further extensive study.

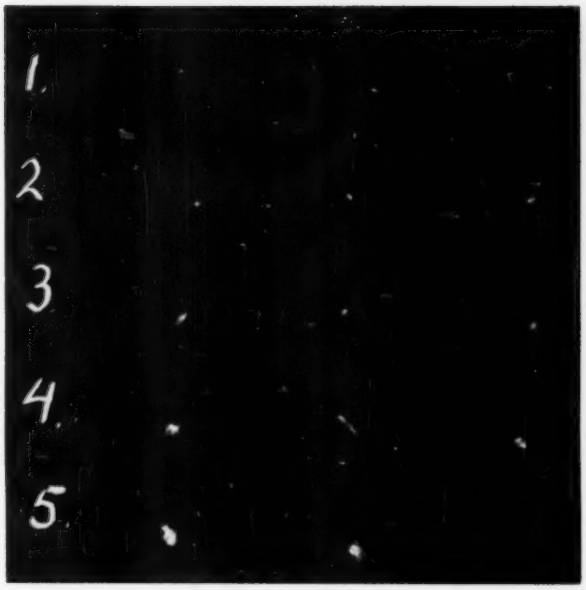

Fig. 4.—Visual comparator illustrating nep size for classification.

Other Methods of Test

Many methods of test relating to wool other than those discussed have been developed by Subcommittee A-3 and other subcommittees, such as ASTM Methods D 1060 for Core Sampling of Raw Wool; D 584 for Wool Content of Raw Wool (Laboratory Scale); D 1334 for Wool Content of Raw Wool (Commercial Scale); D 1113 for Vegetable Matter and Alkali-Insoluble Impurities in Scoured Wool; D 1285 for Tolerances in Woolen Yarns; D 418 for Pile Floor Coverings; D 1230 for Flammability of Clothing Textiles;[12] D 276 for Identification of Fibers in Textiles; D 461 for Felt; D 462 for Wool and Part-Wool Fabrics; D 1425 for Uneveness of Textile Strands; and D 1117 for Nonwoven Fabrics.[13]

Potential Use to Wool Growers, Buyers, and Fabric Manufacturers

For the most part, the developments enumerated which have contributed to the more precise assessment and determination of certain quality factors in wool span less than a quarter of a century, and some less than a decade. As further work is carried out, opportunities for improvement or refinement or new applications are seen. For example, in the fiber fineness field there have been changes in technique, from the long fiber and cross-section procedure to the preferred longitudinal short fiber method. Recently, rapid air-flow methods have come into use, and we also hear of developmental work on the application of electronics to the measurement of fiber fineness and variability. Initially directed mainly to wool top, these advanced procedures will have increased applicability throughout the whole range of processing from the raw material to the finished product.

Just as we have seen improvement in methods and their application in the past, so may we expect further progress in the future. Segments of the wool growing and marketing industry have sought means of applying some of the technological advances to wools still in primary hands. As a result, the Department of Agriculture's Wool Laboratory at Denver has been authorized to aid in this work and has been conducting studies at several wool cooperatives. Through sample testing, using modified laboratory procedures, efforts have been made to ascertain at assembling points information on staple length, fineness, yield, color, etc. If such innovations prove feasible, their introduction should contribute to improvement in the preparation and marketing of the wools of this country. Furthermore, as the wool grower's knowledge of the properties and characteristics of his commodity increases, he will be able to adjust more intelligently his practices and his breeding program.

The work that has been done in the past and that which is now in progress in this field of wool research will, among other things, mean better definition of wool's quality characteristics, make possible more specific determination of the value of lots of wool, make available a better means of differentiating the performance possibilities of lots, facilitate marketing reporting,

[10] *Ibid.*, p. 488.

[11] This has now been issued as Tentative Method of Test for Neps in Wool Tops (D 1770 – 60 T), 1960 Supplement to Book of ASTM Standards, Part 10.

[12] 1958 Book of ASTM Standards, Part 10.

[13] 1959 Supplement to Book of ASTM Standards Part 10.

and provide a common language in business transactions. For its part in this work, Subcommittee A-3 on Wool Fibers can take pride in its contributions to the knowledge of one of the world's great industries.

REFERENCES

(1) E. M. Pohle, D. D. Johnston, H. D. Ray, W. A. Mueller, H. C. Reals, and W. J. Manning, "Fineness Relationship of Raw Wool, Top, Noil, and Per cent Noilage," U. S. Dept. of Agriculture, *AMS-82*, (1956). (A paper presented at International Wool Textile Research Conference, Australia, 1955.)

(2) U. S. Dept. of Agriculture, "Proposal to Amend the Official Standards of the United States for Grades of Wool," *AMS-Federal Register*, March 29, 7 CFR Part 31, 20: 61, 1891–1893 (1955).

(3) E. M. Pohle, D. D. Johnston, H. R. Keller, W. A. Mueller, H. D. Ray, and H. C. Reals, "Value-Determining Physical Properties and Characteristics of Domestic Wools," U. S. Dept. of Agriculture, *Marketing Research Report No. 211*, (1957).

(4) D. D. Johnston, H. R. Keller, W. A. Mueller, H. D. Ray, H. C. Reals, and E. M. Pohle, "Physical Measurements and Their Application in Describing Wool," U. S. Dept. of Agriculture, *Marketing Research Report No. 256*, (1958).

(5) D. D. Johnston, H. D. Ray, W. J. Manning, and E. M. Pohle, "Relationship of Staple Length in Grease Wool and Resultant Top," *Production and Marketing Administration Report*, U. S. Dept. of Agriculture (1951).

(6) E. M. Pohle, D. D. Johnston, H. D. Ray, and W. J. Manning, "Suggested Staple Lengths for Grades of Grease Wool," *Production and Marketing Administration Report*, U. S. Dept. of Agriculture (1953).

(7) D. D. Johnston, H. D. Ray, and E. M. Pohle, "Staple Length Sampling Schedules For Raw Wool Packaged in Bags," U. S. Dept. of Agriculture, *AMS-182*, (1957).

(8) F. J. Poats and Willie Fong, "Economic Evaluation of Color in Domestic Wool," U. S. Dept. of Agriculture, *Marketing Research Report No. 204*, (1957).

Probability Sampling Methods for Wool*

By LOUIS TANNER

AT THE 1949 Annual Meeting of the Society there was presented a paper entitled "Some Problems in the Sampling of Bulk Materials" (1).[1] A Symposium on Bulk Sampling was held during the 1951 annual meeting (2) and another in June, 1958. In 1954, ASTM Committee E-11 on Quality Control of Materials sponsored the Recommended Practice for Probability Sampling of Bulk Materials (E 105).[2] Currently the Society is considering a proposal for a cooperative study of the theoretical and practical aspects of sampling all kinds of bulk materials of importance to industry.

The immediate initial stimulus for these activities was the successful development by D-13 Subcommittee A-3 on Wool Fibers, of the Method for Probability Sampling of Raw Wool (D 1060)[3] first published in 1949. A number of specific problems were encountered in the development of this practicable sampling procedure, problems that may face other investigators on other materials. A brief résumé may prove interesting and enlightening.

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author or authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the meeting of Committee D-13 on Textile Materials, October 16, 1958.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] 1958 Book of ASTM Standards, Part 3, p. 914; Part 4, p. 1373; Part 5, p. 1075; Part 6, p. 966; Part 7, p. 1435; Part 8, p. 1557; Part 9, p. 1952; Part 10, p. 1440.

[3] 1958 Book of ASTM Standards, Part 10, p. 386.

[4] *Ibid.*, p. 300.

[5] *Ibid.*, p. 332.

[6] *Ibid.*, p. 592.

Judgment Samples

What distinguishes Method D 1060 from most other ASTM sampling methods for textile materials is that it purports to be a probability sampling method. Method D 626 on Fire Retardant Properties of Treated Textile Fabrics,[4] for example, merely states: "Samples of not less than 2 sq yd of fabric shall be selected for test." The sampling instruction in Method D 737 on Air Permeability of Textile Fabrics[5] reads: "Five test specimens at least 10 by 10 in., representative of the fabric to be tested, should be provided or tests may be made on the fabric at five places as widely separated as possible without cutting."

For the sampling of cotton fibers, detailed procedures are provided in Method D 1441,[6] the nature of which is illustrated by the following excerpts applicable to a bulk laboratory sample: "Take portions of cotton from different parts of the bulk source sample in order to preserve representativeness and to provide a composite sample that is sufficiently small to be handled easily at the laboratory" consisting of "at least 100 g (4 oz) of cotton or cotton products extracted from the bulk sources sample in a manner to preserve representativeness."

The common characteristics of these and similar sampling instructions in many methods are an awareness of the need for representativeness in samples, and admonitions to secure and preserve representativeness. Just what is meant by this term and how to determine objectively whether or not it has been achieved are not stated. Without doubt, the sampling instructions in our methods have been based on extensive experience, and usually samples adequate for the particular purpose at hand will be obtained when the instructions are carefully followed by experienced operators. However, samples so obtained often depend on the judgment or intuition of the sampler, and we have no objective procedure for evaluating either the judgment of the sampler or the probable limits of error of the sample.

Probability Samples

In contrast with judgment samples there are so-called "probability" samples. The essential characteristic of the latter is that they have been drawn

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by specified procedures such that the precision of the observed properties of the sample may be objectively predicted or estimated by application of the mathematical theory of probability.

The general conditions that must be met in a probability sampling plan are now fairly well known and are described in Recommended Practice E 105. Some of the essential requirements are: actual or imagined subdivision of the material into unique units, or classes of units, each of which has an equal (or known) chance of being drawn into the sample; truly random selection from these units; knowledge of the nature of the distributions of the properties of interest; and estimates of the standard deviations of the distributions. Details of the applicable statistical theory are readily available (**3**,**4**).

There is a considerable gap between a statement of the mathematical conditions for a suitable probability sampling plan for a bulk material and the specific instructions on how to meet these conditions in practice. Sometimes it is physically or economically impossible to meet the requirements under existing conditions. Often, however, the physical and economic obstacles may be reduced or overcome. This was the case with the sampling of wool in packages, described below:

Characteristics of Lots of Raw Wool in Packages

Raw wool appears in commerce in lots of up to several hundred bags or bales ranging in weight from 200 to 1200 lb, depending on the source, but fairly uniform for any one source. Among the properties of interest are the yield, grade or fineness, length of staple, color, tensile strength, crimp, amount and type of vegetable matter present, etc. For many of these properties, laboratory tests are available. The problem is how to obtain, economically, a sample of known and controlled precision on which to conduct the tests.

The properties vary from bale to bale within a lot and from portion to portion within a bale. The variability of some properties may be quite high. For example, a lot of greasy Australian wool may consist of bales differing in percentage of wool content by as much as 30 per cent. The range in yield between two portions of wool from the same bale may also be of the same order of magnitude. With such heterogeneous material, the selection by judgment of a laboratory-size representative sample is most difficult and, as experience has shown, often fails by a considerable margin.

Features of Sampling Method D 1060

The essential features of Method D 1060, the method devised to meet this situation, are:

1. A practical coring device is described by means of which a small portion of wool may be obtained economically and conveniently from an unopened bale.

2. A tabulation is provided of the standard deviations of the percentage of wool content between bales in a lot and between cores within a bale, for each major type and source of wool. This tabulation is based on very extensive experimental data obtained over a number of years.

3. Detailed operating and other instructions are given for proper two-stage sampling, that is, for the selection of primary units (bales) and the drawing of secondary units (cores).

4. Two formulas are presented which together enable one to calculate the most economical two-stage sampling plan for the desired level of precision. A sampling plan consists of a specification as to the number of bales to be sampled and the uniform number of cores to be taken from each of these bales.

Problems in Development of Method D 1060

Sampling Device.—Perhaps the most important factor contributing to the successful development of the sampling procedure for wool was the invention of the coring tube. Very often success or failure hinges on the means available for taking a secondary unit of material. The design of the device must meet certain requirements. Obviously, the device must not change the property under investigation. One cannot use a coring tool that cuts fibers if the staple length is to be measured; for this purpose a different tool must be used, such as the barbed spear, also devised by Subcommittee A-3 and described in the Method of Sampling and Testing Staple Length of Wool in the Grease (D 1234).[7] Friction in coring generates heat which may affect the moisture content. This factor is important in sampling for wool yield but not for fiber fineness. In connection with the former, accordingly, studies were necessary to determine optimum methods for reducing frictional heating effects—speed of rotation, nature of cutting edge, alternation of sampling tubes, tube wall thickness with relation to diameter, finish of the exterior metal surface, etc.

Less obvious is the effect of the design of the cutting edge, smooth or serrated. The latter cuts cores more easily under certain conditions, but some tooth designs may alter the content of some impurities included with the core. Again, the absolute and relative tube diameter and wall thickness may be critical for different types of pack and condition of the wool. A uniformly small-diameter device may merely push loosely packed wool aside without coring it; on the other hand, with densely packed wool it is easier to cut and to penetrate with a small-diameter tube with an even smaller cutting edge. Many other design details of critical importance for wool sampling could be cited. In the general case, no factor should be overlooked; success or failure may depend on the sampling device used.

A different problem that may be encountered is this: To what extent does the sampling device or procedure damage the material sampled? One would not think of cutting a section through a bolt of expensive fabric, even if this would most easily produce the most representative sample. In the instance of baled wool, opposition was immediately encountered from those who feared that a coring device would materially increase the noilage of the wool. Such fears, if well founded, would at once make such a device unsuitable. Experimental investigation of this question by the task group was not feasible. However, an elegant solution was arrived at mathematically. Equations were derived for calculating the distribution of cut fiber lengths both within a bale after coring and within the core itself. Fortunately, the calculated increase in noilage was found to be negligible under the proposed conditions of sampling. These equations are applicable to other similar situations and fibers; they, together with their derivation, have been published (**5**).

Statistical Data.—The calculation of a sampling schedule by means of the equations previously referred to presupposes that we have knowledge of the magnitude of the components of variance involved. We never really know the exact values, but good estimates are quite satisfactory. Sometimes such estimates are readily made from existing information. Often, as in the case of wool, data are lacking. The accumulation of such data for wool was a long, tedious job involving thousands of tests on individual cores. The estimates obtained from this study appear to be reasonably constant for each class of wool, but there is no assurance that they will remain so, since they depend in part on changing practices of preparation, grading, packaging, and formation of lots. Continuous re-evaluation of the statistical parameters is necessary. If the cores were not composited, this could be easily done with the data from routine testing. With composited samples we lose this statistical data. A procedure for checking variances economically by a slight modification of the compositing practice has been developed by the subcommittee and has been described (**6**). The subcommittee makes periodic revisions in the tabulated

[7] *Ibid.*, p. 460.

variances to reflect current conditions insofar as possible.

Effect of Compositing.—Composited samples do not furnish statistical data, as just mentioned. Another difficulty with composited samples is this: the weight of each secondary unit (core) in two-stage sampling must be proportional to the weight of the primary unit (bale) from which it is drawn. Failure of proportionality may lead to an inflation of the sampling error or even to a bias if the variation in proportionality is correlated with the variation of the property of interest. To illustrate: Bales of wool in a lot do vary in weight as well as in percentage of wool content. Furthermore, individual cores also vary in weight even when they are of the same apparent volume and taken with the same coring tool. If the cores taken from low-yield bales were consistently heavier, proportionately, than cores from high-yield bales, the composite sample would be biased, showing too low an average yield. This would be a serious defect. Accordingly, a correlation study was made in the course of developing Method D 1060. It showed that in only rare instances was there sufficient correlation to result in any noticeable bias when coring was properly and conscientiously performed in accordance with the written instructions. The fortunate circumstance encountered in this instance cannot be presumed to exist for all commodities when compositing of samples is used. For wool it was found sufficient to incorporate a simple safeguard in the method: the variation in the weights of bales that may be included in a lot for sampling purposes is restricted, and it is specified that all cores drawn from a lot be of approximately the same dimensions.

Direction of Boring.—Reference has been made to the components of variance, the statistical measures of variability that control the size (number, not weight) required for a desired precision. In general, the size of sample required is proportional to the square of the standard deviations involved. When the magnitude of the variances is great, so large a sample may be required as to make probability sampling prohibitively expensive. We must remember, however, that the variabilities are between specific units, and one type of unit may be much more uniform than another in a given set of circumstances. Wise planning and design may greatly reduce the variance between units; wool sampling by coring affords an illustration.

Consider a bale of Australian fleece wool. It is packaged by laying fleeces in the baling machine in layers, so the wool is in effect stratified. There is more variation between cores taken parallel to the layers than between cores taken perpendicular to the layers. The latter are obviously preferable, for this reason, as the secondary units, and this is generally the case with stratified material. Another and very important advantage of cutting across strata is the fact that usually the size and weight of the secondary units may be materially decreased without increasing their standard deviation. How this comes about may perhaps best be visualized by an examination of Fig. 1.

Figure 1 is a photograph of part of a core of Australian fleece wool bored normal to the layers, that is, in the direction of bale compression. The disks are sections removed from the corresponding locations along the length of the core. It is at once obvious that there is considerable variation in the cleanliness of the wool in the axial direction and relatively little variation in the radial directions. Reduction of the core diameter would scarcely affect the variation between independent cores, yet the weight of these smaller-diameter cores would be reduced as the square of the ratio of diameters. Any tendency toward increased variability due to diameter reduction could easily be offset by a slight increase in core length. These inferences were conclusively verified experimentally in the case of such packaged wools. A mechanically satisfactory 0.4-in. diameter sampling tube was developed for use where 2-in. diameter tubes were formerly used. A 1-lb composite sample can thus be obtained that is just as representative as the 25-lb sample formerly taken. Not only is sampling and preparation for test much more economical, but the test result itself is more accurate, since subsampling is no longer required; the gross sample is the laboratory-size test specimen.

Another advantage, peculiar to wool sampling, may be mentioned in connection with drilling the cores perpendicular to the layers of wool in a bale. The cores break cleanly at the layer of maximum penetration so that the core is retained in its entirety within the tube upon withdrawal. This is not the case with cores taken parallel to the layers; there may not be a clean break and a variable portion of the cut core may be pulled out of the tube. This factor may be of importance in view of the previous discussion in connection with proportionality.

Randomness.—Of the many other important aspects of probability sampling exemplified in Method D 1060, mention will be made of only the requirement for true randomness in the selection of the bales to be cored and in the location of the borings. Without randomness, there can be no controlled or knowable precision. The achievement of randomness may be impossible in some circumstances, but in many seemingly impossible situations foresight, planning, and the application of engineering skill make it possible to meet this requirement economically. For a competent statement of the meaning and importance of randomness in sampling and how it may be achieved, it is recommended that careful consideration be given to the Appendix of Recommended Practice E 105.

Accuracy.—It is proper to inquire how accurate, in fact, are probability samples taken in accordance with a given plan. Only by comparing the results found on samples with the findings on the entire lots can we be sure that some vital factor has not been overlooked, that some bias does not exist, that some slip has not occurred between mathematical theory and its physical application. Desirable though such a comparison is, it is not always feasible; mill operations do not usually conform to the requirements for accurate comparisons. In the case of wool, special arrange-

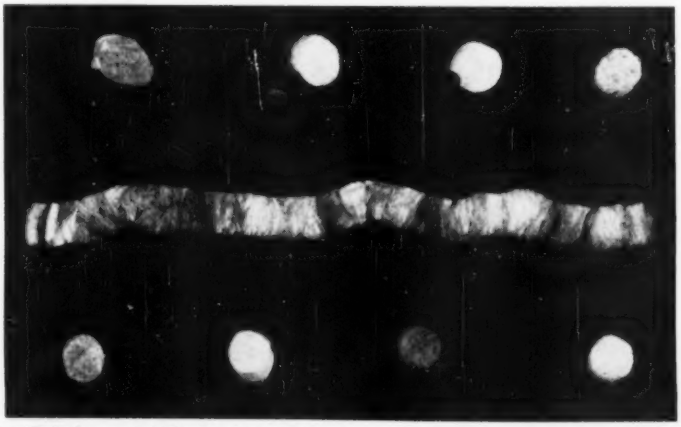

Fig. 1.—Relative variability in cleanliness of a core of wool in the radial and axial directions. Core taken from a bale of Australian fleece wool in the direction of compression.

ments made it possible to obtain accurate mill results for comparison with sample results in about 20 cases. These comparisons were all favorable, offering convincing proof of the absence of bias in Method D 1060 and the achievement of the predicted, desired precision when the instructions are carefully and competently followed.

Conclusion

From this brief recital of experiences in developing a probability sampling plan for a specific bulk material, wool, perhaps the most pertinent conclusion is that the step from a mathematical model to a practical operation is not easy; it involves considerable effort, study, investigation, development and ingenuity. This is similar to the situation encountered in the preparation of a test method. Just as we accept it as necessary in the latter case, so we must also for the development of sampling methods. The need for good samples that do not depend on judgment or intuition is no less than the need for test methods that are scientifically correct and that do not depend on an individual's subjective judgment. The considerable effort that ordinarily goes into a test to achieve high accuracy and precision is wasted if we do not know how good the sample is; in fact, highly precise analytical results may be utterly misleading in such cases, since we tend to assume that the precise results apply to the lot of material as well as to the sample.

Finally, a suggestion is offered to those who prepare ASTM methods and specifications. Many sampling instructions and schedules read as though they are judgment sampling plans when in fact they are based on sound statistical data. When this is the case, it would be very helpful if this fact were indicated in the method, together with a summary of the pertinent information either in a paragraph, a note, or an appendix. An illustration of how this has been done is shown in the Methods of Testing Twine from Bast and Leaf Fibers (D1233).[8]

[8] *Ibid.*, p. 455.

References

(1) L. Tanner and W. Edwards Deming, "Some Problems in the Sampling of Bulk Materials," *Proceedings*, Am. Soc. Testing Mats., Vol. 49, p. 1181 (1949).

(2) Symposium on Bulk Sampling, *ASTM STP No. 114*, Am. Soc. Testing Mats. (1951).

(3) ASTM Manual on Quality Control of Materials, *ASTM STP No. 15-C*, Am. Soc. Testing Mats. (1951).

(4) W. Edwards Deming, "Some Theory of Sampling," John Wiley and Sons, Inc., New York, N.Y. (1950).

(5) I. Michelson, L. Tanner, and H. J. Wollner, "The Distribution of Cut Fiber Lengths in Wool Sampled by Cylindrical Tube Borings," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 14, p. 949 (1942).

(6) L. Tanner and M. Lerner, "Economic Accumulation of Variance Data in Connection with Bulk Sampling," Symposium on Bulk Sampling, *ASTM STP No. 114*, Am. Soc. Testing Mats., p 8 (1951).

Recent Developments in Test Methods for Wool*

By WERNER VON BERGEN

THE main purpose of this paper is to establish a basis to further the wool standardization work of the Society by reviewing the newest physical and chemical tests used in research and in testing wool fibers. To this end the following subjects will be discussed:

1. An Electronic method for moisture determination.
2. An improved air-flow method for measuring fineness.
3. An electronic method to determine the number and size of fibers.
4. A new approach to a speedier electronic fiber length method.
5. A method of predicting differential dyeing behavior of wool.
6. A method for determining alkali damage to wool.
7. A method for determining the nature of the cortex in animal fibers.
8. The need for an improved method to measure the visco-elastic properties of wool.
9. Specification and test methods for cashmere and other specialty hair fibers.
10. The need of a better method for determining the felting properties of wool.

Speakman (15)[1] has pointed out that the systematic, scientific study of wool textile materials, machinery, and processes is only about 35 years old, and therefore it is no surprise that the influence of the craftsmen based on the experience of countless generations still exceeds that of the scientist. For this reason many of our present ASTM methods are still not recognized by many wool growers, merchants, and manufacturers. But this should not discourage us, because the progressive members of the wool industry are calling on us to supply them with still more accurate information. To do this we must use the latest available information in the field of wool technology. The main demand is simply for faster and more precise methods.

Electronic Method for Moisture Determination

The outstanding example is the determination of moisture. Merely to establish the moisture content for commercial or research purposes may not be specific enough for mill control. The comber and spinner is interested in the actual amount of water present in the fiber during processing and what influence the water has on processes such as carding, gilling, combing, drawing, and spinning. For this he needs an instrument with which he can establish the moisture content at the machine within minutes. In most laboratories and mills the basic method is still the oven method. It has been speeded up,

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* Presented at the meeting of Committee D-13 on Textile Materials, Oct. 16, 1958.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

WERNER von BERGEN, associate director of research of J. P. Stevens & Co., Inc., Garfield, N. J., for 31 years was director of research of Forstmann Woolen Co. He served for 15 years as chairman of Section 1, Subcommittee A-3 on Wool of Committee D-13 on Textile Materials, and an additional ten years as chairman of Subcommittee A-3. For ten years he taught woolen manufacturing at Columbia University. Mr. von Bergen is co-author of the American Wool Handbook and the Textile Fiber Atlas. He was the recipient of the Olney Medal in November, 1952, and the Harold DeWitt Smith Award in March, 1960.

Fig. 1.—Forté electronic moisture content analyzer, Model K, for 20-oz bulk fiber.

reducing the time from 1 hr to less than 15 min, but the method is still confined to the laboratory, and much time is consumed in getting samples from the manufacturing units to the laboratory.

Many attempts have been made with various electrical gadgets to make the determination on the spot. However, only recently, with the introduction of the electronic moisture content analyzers such as the Shaw constant pressure type moisture meter (an English instrument) and the Forté electronic moisture content analyzer, have we had a method that fulfills today's requirements for accuracy and speed.

The Forté electronic moisture content analyzer determines the moisture content of fibers by measuring their dielectric constant. A direct relationship exists between moisture content and dielectric constant of various fibers such as wool, cashmere, mohair, and man-made fibers. The following three models have so far been developed:

Model K

Model K shown in Fig. 1, utilizes a 20-oz sample of bulk fiber material and measures the moisture content by determining the dielectric constant. This model will determine moisture content in the range of 1 to 25 per cent.

To make a moisture determination, the operator inserts the 20-oz sample in a test cell, which is about 14 in. in diameter by 9 in. deep. A pneumatic cylinder closes the plunger lid. A reading of relative dielectric constant on an electric panel meter is immediately obtained on a scale numbered from 0 to 100. By reference to a calibration chart, this meter reading is converted to moisture content. The entire process takes about 30 sec. The precision and repeatability are 0.1 per cent, with the accuracy equal to that of the calibrating means.

To check the performance of the instrument and the calibration chart, two brass slugs are prepared which are equivalent electrically to the sample material at two different moisture contents. The machine is standardized as often as desired by observing the meter readings from these slugs, which are inserted consecutively in the test cell.

Model D

Model D (Fig. 2) determines the average moisture content (2 to 17 per cent) of a ball of wool top in about 30 sec. The entire ball of top is inserted in the test cell. The sample size may vary from 7 to 24 lb. Operation of the instrument consists of merely weighing the ball of top, then inserting the entire ball into a test cell. A lid is closed by actuating an air valve. A panel meter instantly reads the relative dielectric constant. A calibration chart furnished with the instrument relates moisture content to meter reading against the weight of the ball of top. To check the stability of the calibration, two electric equivalents to known balls of wool top are supplied with the machine.

Fig. 2.—Forté electronic moisture content analyzer, Model D, for balls of top.

Experience has shown that the moisture-content gradient within one ball of top may be as high as 2 per cent, with 0.5 per cent variations quite common. Studies on single balls show 65 per cent of determinations made by the Forté Model D will agree within 0.5 per cent (moisture content) with determinations made by oven-sampling the same ball. Practically all determinations agree within ±1.0 per cent (moisture content).

Model F

Model F (Fig. 3) determines the moisture content (1 to 20 per cent) of a cone of yarn, any size, in 15 sec. The test measures the average moisture throughout the entire cone. Operation consists of merely weighing the cone of yarn and inserting it in the test cell. An electric field permeates the yarn and a panel meter instantly indicates a value between 0 and 100. A calibration chart relates moisture content to meter reading against weight of the yarn.

Figure 4 shows the correlation curves for cashmere, wool noils, and carpet wools, giving the instrument readings and their correlation with moisture content. A study has shown that Model K produces readings which have a standard deviation of less than 0.1 per cent moisture, irrespective of the moisture content of the sample, fiber type, or machine. Correlation tests of 240 measurements have also shown that the varying amounts of oil in wool tops have no effect on the readings. Neither are the analyzer readings affected by the pH of the material in a range of 6 to 18 per cent moisture and pH of 6.6 to 8.9.

Fig. 3.—Forté electronic moisture content analyzer, Model F, for cones of yarn.

Improved Air-Flow Method for Measuring the Fineness of Wool

The air-flow method of measuring wool fiber fineness, on which the Micro-

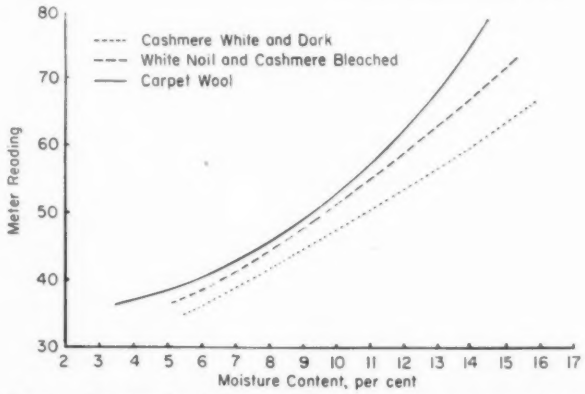


Fig. 4.—Relationship between moisture content and meter reading for cashmere, wool noils, and carpet wool.

[3] 1958 Book of ASTM Standards, Part 10, p. 473.

naire method is based (ASTM Method D 1282),[2] is extensively used in England and in Belgium. It is based on work done by F. Monfort and the members of the technical committee of the International Wool Textile Organization (7).

The essential parts of the WIRA (Wool Industry Research Assn.) fineness meter (Figs. 5 and 6) are for the most part the same as the Micronaire. However, it has certain worth-while improvements. They comprise (1) a cylindrical chamber, A, with perforated ends into which the test sample is packed; (2) a flow meter, F, to measure the rate of air flow through the fibers; (3) a manometer, C, to measure the pressure differences; and (4) a pump to provide an air current through the fibers (not shown). In the Micronaire, the air is blown under pressure through the fibers. The WIRA meter draws air from the room through the fibers, which provides less chance of effects due to air heating and contamination in the compressor.

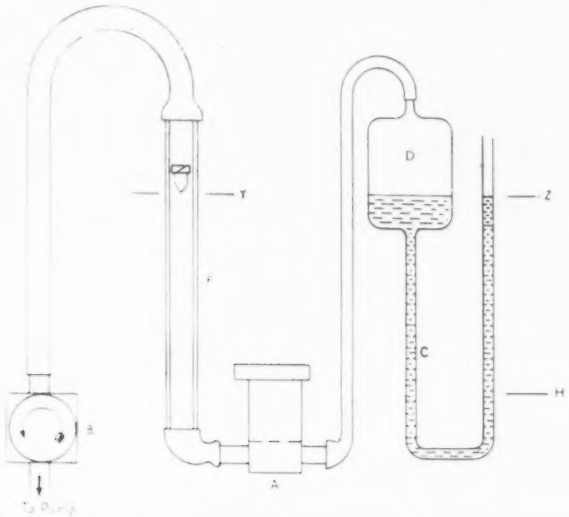


Fig. 5.—General arrangement of the apparatus for WIRA fineness meter.

The apparatus is used in two forms for measuring wool tops between 18 and 40 μ. The following equation gives the law relating fiber diameter, d, to the observed variables and other constants.

$$d^2 = K F (1 - e)^2 L / e^3 P A \quad \ldots\ldots (1)$$

where:

F = flow rate of air, ml per sec,
e = $1 - M/1.31 A L$,
M = mass of fiber, g,
P = air pressure across fibers, cm of water,
A = cross-sectional area of tube, sq cm,
L = effective length of constant-volume chamber, cm, and
K = constant for particular values of e, L, and A.

It can be seen from Eq 1 that, if the instrument is adjusted to give a constant reading on the flow meter, the manometer may be graduated directly in microns or, alternatively, the flow gage may be graduated in microns and the air flow adjusted to give a fixed pressure. Since d^2 varies directly as flow rate but inversely as pressure, graduating the flow meter in microns leads to a much more even scale. The factor e in Eq 1 represents the volume of air space to total space in the packed tube.

Courtesy Peltzer & Fils, S.A., F. Monfort

Fig. 6.—WIRA fineness meter.

The actual working range of the flowmeter and manometer is, in theory, not important. In practice, there are advantages in using moderately high flow rates so that (1) scale readings on the manometer and flow gage may be read with reasonable accuracy, and (2) the fibers are quickly conditioned by the air drawn through them.

With this apparatus, two methods may be used:

Method A is based on a constant flow with the manometer calibrated in microns, and is useful when only a small amount of combed sliver is available. With the stated amount of sliver (1.2 $\pm$0.001 g) and the flow meter marked at 28,000 ml per min, it is found that for a mean fiber diameter of 19 μ the pressure is about 41 cm of water, and for a mean fiber diameter of 40 μ the pressure is about 11 cm of water; this gives a total scale of 30 cm, with the greatest discrimination at the fine end.

Method B is based on constant pressure with the flow gage graduated in microns giving an approximately linear scale. The sample size is 2.5 g weighed to 0.005 g. The American version of method B, as described in ASTM Method D1282, uses the Micronaire. The constant-volume chamber of the Micronaire is considerably larger and requires a sample size of 5.9 $\pm$ 0.010 g. Interlaboratory tests with European laboratories should be made to show if any advantages may be gained by incorporating some of the European techniques into the present ASTM method.

Electronic Method to Determine the Number and Size of Fibers

The Coulter Electronic Co. has developed the Coulter counter for establishing the particle content and size distribution of virtually any type of particle. This instrument (Fig. 7) was first developed for the use of biological cells such as hemoglobin.

Principle

The method determines the number and size of particles suspended in an electrically conductive liquid. The suspension flows through a small aperture having an immersed electrode on either side, with particle concentration such

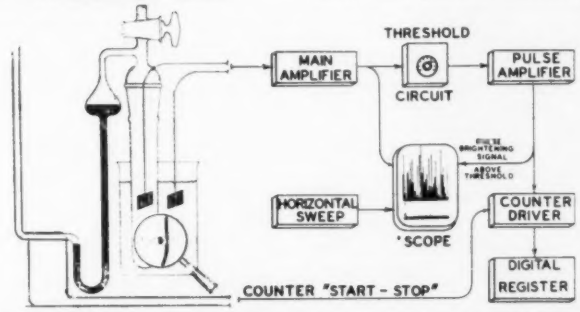


Fig. 7.—Diagram of basic mechanism and principle of Coulter counter.

that the particles traverse the aperture substantially one at a time.

Depending on the nature of the sample, the aperture size must be two or three or more times the diameter of the largest particles of the sample. For example, for wool having as its largest diameter 70 μ, the aperture would be 200 μ. The lowest standard aperture size made is 30 μ.

Each particle passage displaces electrolyte within the aperture, momentarily changing the resistance between the electrodes and producing a voltage pulse proportional to particle volume. The resultant series of pulses is electronically amplified, scaled, and counted. The pulse pattern on the oscilloscope screen serves as a guide for measurement and as a monitor of instrument performance. The pulses are also fed to a threshold circuit having an adjustable screen-out voltage level, and those pulses that reach or exceed this level are counted. Threshold level is indicated on the screen by a brightening of pulse segments above the threshold level.

The electrolyte in the aperture forms the principal resistance between the electrodes, and the resistance change due to particle passage is:

$$\Delta R = \frac{P_0 v}{A^2} \frac{1}{\frac{1}{1 - P_0/p} - \frac{a}{xA}}$$

where:

P_0 = electrolyte resistivity,
A = aperture area normal to axis,
v,p,a = particle volume, effective resistivity, and area normal to aperture axis,
x = particle dimension ratio, $1/d$,
= $\frac{\text{length parallel to aperture axis}}{\text{diameter of equivalent sphere}}$

Thus, for given aperture size and electrolyte, response is primarily proportional to particle volume. Minor "side effects" are readily avoided or may be suitably reduced by correction.

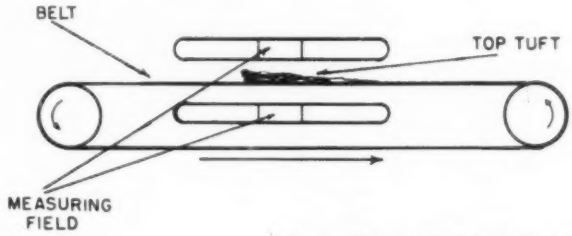
Operation

When the stopcock is opened, a controlled external vacuum initiates flow from the beaker through the aperture and unbalances the mercury manometer. Closing the stopcock then isolates the system from the external vacuum, and the siphoning action of the rebalancing manometer continues the sample flow. The advancing mercury column activates the counter by start and stop probes, providing a count of the relative number of particles above a given size in a fixed volume of suspension (for example, 0.5 ml). The stopcock is opened, the counter reset, and a fresh volume drawn for each count. A series of counts from the sample beaker at various threshold settings provides direct data for plotting particle volume versus cumulative frequency.

On a routine basis, ten-point size distribution data may be obtained in 10 min or less. (A single count requires 5 to 25 sec.) Preliminary tests have shown that success in determining the fineness of fibers depends on holding the fiber length to a constant value with as little deviation as possible.

New Approach to a Speedier Electronic Fiber Length Method

To perform one analysis on fiber length of wool top as described in ASTM Method of Test for Fiber Length of Wool Tops (D 519)[3] requires $\frac{3}{4}$ to 1 hr including calculations. The best-known instrument of a semi-automatic nature is the Schlumberger fiber sorter, which is used in many European wool laboratories. Even with this machine it takes 40 min for one analysis. Work is underway on an electronic method shown in Fig. 8 which uses the principle of the Uster top and yarn testing machine.



Courtesy Peltzer & Fils S.A., F. Monfort

Fig. 8.—Diagrammatic sketch of electronic measuring device for fiber length of top.

In preparing the sample the same technique could be used as is described in Method D 519, where a drawing clamp is used to take a tuft of fibers from the square top. This tuft of fibers is laid on a nonconductive apron which passes the tuft through a measuring slot. The integrator registers, in curve form, the thickness variation along the length of the tuft. It is obvious that the time factor in such a method would be very small.

In 1959 the first such instrument, the WIRA fiber length meter (9), was placed on the market. The stated testing time for one sample with this instrument is 12 min. In 1960 the Scientific and Technical Institute of the Belgian Textile Industry announced the introduction of their A-L meter, manufactured by Manufacture Belge de Lampes et de Materiel Electronique, S. A., of Brussels, Belgium. The stated testing time for one sample is about 5 min.

A Method of Predicting Differential Dyeing Behavior of Wool

This subject is covered by the ASTM Method of Test of Predicting Differential Dyeing Behavior of Cotton (D 1464).[4] It is based on dyeing a test specimen of cotton simultaneously in a bath containing a mixture of two direct cotton dyes of contrasting colors in red and green, of different dyeing characteristics. The red dye is retained predominantly by the thick-wall fibers and the green by the thin-wall fibers. A similar method is needed in the wool field, namely, to establish the tippiness of a wool. The material for a suitable method appears in the paper of the New York Section on tippy dyeing of wool (10). Two dyes which can be used simultaneously are Neolan Red 3B and Alizarine Astrol B.

The recipe is as follows:

Neolan red 3B (CI Acid red 191)	0.25 per cent
Alizarine astrol B (CI Acid blue 27)	0.30 per cent
Glauber salt	10 per cent
Acetic acid 28 per cent	5 per cent

The best results are achieved by starting the dyeing at 175 F, then bringing to a boil within 15 min, and boiling for 30 min. The sunlight-damaged tips will attract the acid red, dyeing them dark red, whereas the rest of the staple will absorb the acid blue. After the samples are dyed, they are prepared as described in Method D 1464.

A Method for Determining Alkali Damage to Wool

The ASTM Method of Test for Alkali-Solubility of Wool (D 1283)[5] is extensively used as a means of arbitrarily measuring chemical changes in wool brought about in such processes as peroxide bleaching, chlorination, carbonizing, and acid dyeing. The solubility of untreated wool under the condition of the standard method is about 11 to 14 per cent. It increases when the wool undergoes any of the above processes to an extent which depends on the condition of the treatment, namely, temperature, time, concentration of reagent, etc. The in-

[3] *Ibid.*, p. 228.
[4] *Ibid.*, p. 649.
[5] *Ibid.*, p. 477.

crease is probably caused by oxidation or hydrolysis of the main peptide chains or fission of the disulfide linkages.

Unfortunately the alkali solubility test has been used indiscriminately for all kinds of chemical processes, thereby discrediting it. The test is specifically only for measuring the damage caused by the oxidation process. The method, for example, is of no use where the wool is subjected to alkali treatments.

Lees and Elsworth (**13**) have found that for such treatment the solubility of wool in a urea bisulfite solution can be used as a measure of fiber modification or degradation. They state that many of the processes to which wool is subjected are carried out under alkaline conditions—for example, scouring, crabbing, setting, and decatising. In the alkali solubility test, alkali-treated wool gives a lower result than untreated wool, because either some part of the alkali-soluble protein is removed in the alkaline treatment itself, or the formation of new resistant cross-linkages in the wool causes its actual solubility to decrease. The decrease is necessarily small, and, as a measure of the effect of an alkaline treatment, the alkali-solubility test as presently used is insensitive.

Jones and Mecham (**12**) have shown that the keratin proteins can be partly dispersed in a neutral solution of a protein denaturant, for example, urea, in the presence of a reducing agent (sodium bisulfite), capable of splitting the disulfide linkages, an essential preliminary reaction in the dispersion of the keratins.

Lees and Elsworth (**13**) have now shown that when wool is treated in alkali its solubility in urea bisulfite solutions decreases and it can be rendered virtually completely insoluble by a moderately severe alkaline treatment. On the other hand, treatment of the wool under acidic conditions causes an increase in solubility as in the alkali insolubility test.

The effects of different treatments on the amount of wool dissolved in 1 hr by a solution containing 50 per cent urea and 3 per cent sodium bisulfite at 65 C are given in the following table:

Treatment	Solubility in Urea Bisulfite, per cent of dry weight	Cystine Sulfur Content, per cent of dry weight	Alkali Solubility, per cent of dry weight
Untreated[a]	52.6	2.95	13.4
Boiled for 3 hr at pH 8.2	8.1	2.36	13.5
Boiled for 3 hr at pH 2.2	72.4	2.91	35.0

[a] The samples of untreated wool referred to were undyed worsted yarn and were not identical.

According to Kessler and Zahn (**14**), this method has now been widely adopted as the most sensitive method for detecting pretreatment of the wool fibers with alkali. Some of Zahn's experiments showing the effect of a soda treatment on the urea bisulfite solubility are shown in Fig. 9.

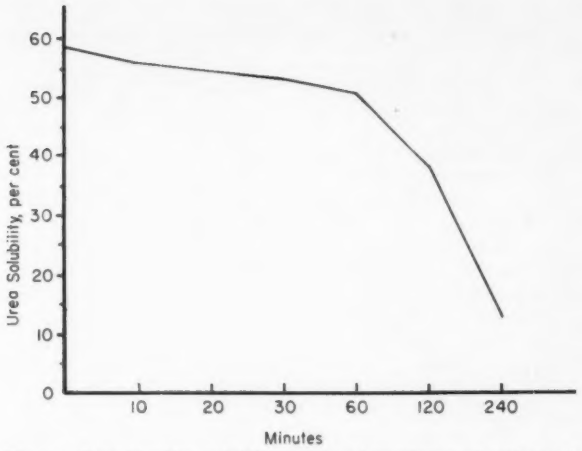


Fig. 9.—Urea bisulfite solubility, effect of treating wool with 0.1*N*.

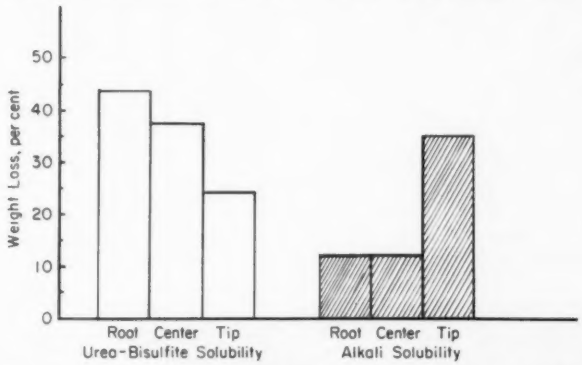


Fig. 10.—Wool staple solubility analysis (Columbian wool staples, solvent-cleaned).

The effect of treating wool with 0.1 *N* Na_2CO_3 solution at 45 C is shown in the following table:

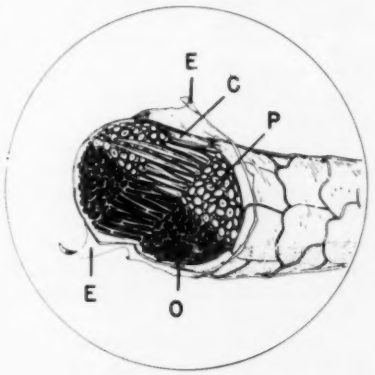
Time of Treatment, min	Cystine and Cysteine Content, per cent washed	Urea-Bisulfite Solubility, per cent washed
0	12.49	48.8
10	12.49	45.4
20	12.51	44.0
30	12.44	31.3
45	12.44	24.7
60	12.36	21.6
90	12.25	17.1
120	12.16	12.4
240	11.47	6.3

Further tests to compare urea-bisulfite solution with the alkali solubility were run on raw wool staples in the J. P. Stevens Central Research Laboratory. The results are shown in Fig. 10.

Method for Determining Nature of Cortex in Animal Fibers

Considerable strides have been made in the past few years in the histology of keratin fibers. Interest has been focused on the subject by Speakman's observation (**15**) of the wide differences in visco-elastic properties between the fibers grown by the primary and secondary follicles of the sheep; and by Horio and Kondo's discovery (**16**) of the bilateral nature of the cortex of fine-crimped wool fibers.

Laboratory methods to measure these properties have been worked out. The importance of both of these discoveries



E—Epicuticle
C—Cuticle
O—Orthocortex
P—Paracortex

Fig. 11.—Structure of Merino wool fiber.

are such that the ASTM should study the possibility of working out specific test methods.

The bilateral structure of the wool fiber cortex has been demonstrated by research workers at the Textile Research Inst. (19) as well as by others (Fig. 11). According to this concept, the wool fiber cortex, *C*, consists of two semicylinders running lengthwise through the fiber and twisted around one another in phase with the fiber crimp. The portion more resistant to chemical attack has been called the paracortex, *P*, and the remainder the orthocortex, *O*. The customary way of identifying these two sections has been by preferential staining with various dyes such as methylene blue. The orthocortex, on the outer or convex side of the crimp curvature, is the more heavily stained portion.

Other keratin fibers were investigated using the dyeing technique. It was found that in Buenos Aires fleece wool, which possesses no crimp, the orthocortex exists as a central core surrounded by a sheath of paracortex. Kid mohair staining uniformly with basic dyes is an orthocortex fiber, whereas human hair seems to be mainly a paracortex-type fiber (Fig. 12).

Cross-sections made by Fraser and Macrae (18) show that crimpless Merino fibers correspond to the ring formation of the ortho-paracortex as found in the straight Buenos Aires wools (Fig. 13).

Need for an Improved Method to Measure the Visco-Elastic Properties of Wool

A test for measuring the visco-elastic properties of wool should be a practical one that could be run in the average wool laboratory. For such a test the use of a testing instrument like the Instron machine is a necessity. The high cost of an instrument should not be the governing factor in the development of test methods, as has so often been the case. With the adoption of the Instron-type instrument for industrial laboratories, it is definitely the duty of the ASTM to develop such a method.

A good example of what can be done is the ASTM Method of Test for Linear Density of Textile Fibers by the Vibroscope (D 1577).[6]

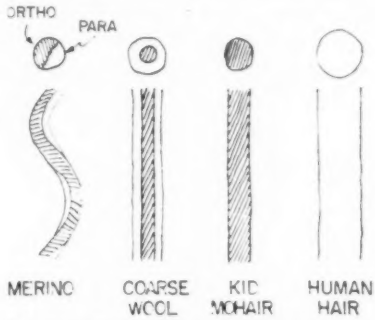
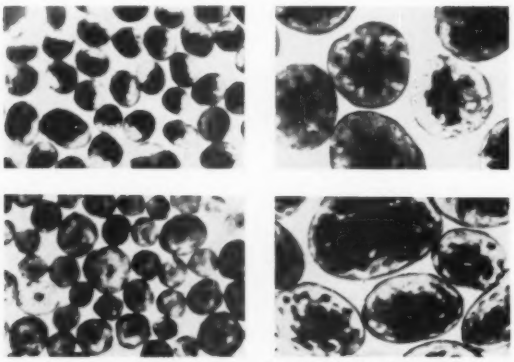


Fig. 12.—Orthocortex and paracortex distribution in various keratin fibers.



Courtesy Textile Research Institute

Fig. 13.—Cross-sections of wool and mohair dyed with methylene blue, illustrating the transition from a bilateral asymmetry of basic dye affinity in the cortex of Merino wool (*a*), to one of radial asymmetry in crimpless Merino wool (*b*), Lincoln wool (*c*), and mohair (*d*) (× 300). Reduced one fourth in reproduction.

Specifications and Test Methods for Cashmere and Other Specialty Hair Fibers

Specifications and methods are available for fineness of wool (ASTM Method D 419)[7] and mohair fibers (D 1381).[8] However, we still lack specifications for such fibers as cashmere, camel hair, and the fibers of the llama family, alpaca and vicuna.

The importance of this work has become very clear in the past few years owing to the bad practice of mislabeling fabrics containing such fibers. Work on cashmere is under way in Committee D-13. The first round-robin data indicates that we have to go back to the cross-section method. Figure 14 shows a cashmere cross-section.

Need of a Better Method for Determining the Felting Properties of Wool

The test for felting properties should be one that could be run on scoured wool or wool top to determine whether the wool would make a good felt or would full well in subsequent manufacturing operations. While work was done along these lines by the Harris Research Laboratories in developing a method for estimating the degree of shrink resistance of treated wool in top form (18) considerably more development of the method is necessary to make it suitable for the above purpose.

Conclusions

Most of the present methods and specifications covering the wool field have been arrived at through round-robin testing. The agreements arrived at by fellow craftsmen through this type of testing have become the backbone of wool technology today.

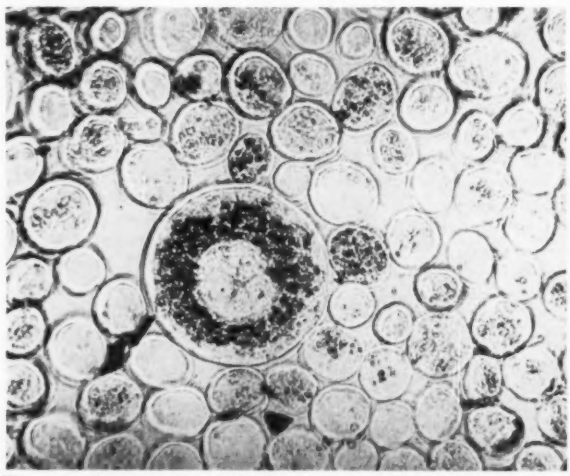


Fig. 14.—Cross-section of cashmere, down fibers and one beard hair in center (× 500). Reduced one fourth in reproduction.

The development of these techniques has taken place in Subcommittee A-3 on Wool Fibers of Committee D-13. It was the early acceptance of the principle of statistical analysis in the examination of laboratory data which made the findings and conclusions reliable. Therefore, the statistical approach is the bedrock of progress in any new development, and only by using this approach will we succeed in establishing the methods I have suggested.

The most dramatic feature of this age of fiber science is, of course, the rise and development of man-made fibers. Even though the rate at which technical developments take place is little

[6] *Ibid.*, p. 692.
[7] *Ibid.*, p. 188.
[8] *Ibid.*, p. 556.

short of alarming to many who serve in the woolen industry, there is no reason why we should be discouraged. On the contrary, let us be instilled with the same enthusiasm as are the men of the synthetic-fiber industries to greater endeavor with a fiber which is still one of the most useful and beneficial to mankind—and I dare to add—will be for generations to come.

REFERENCES

(1) Werner von Bergen, "Testing the Physical and Chemical Properties of Wool by Means of the Microscope," *Proceedings*, Am. Soc. Testing Mats., Vol. 35, Part II, p. 705, 1935.

(2) "The Shaw Constant Pressure Type Moisture Meter," *Journal of the Textile Inst.*, Proc. and Abstr., Vol. 49, p. 274 (1958).

(3) Stanley Breen, "Forté Electronic Moisture Content Analyzer," unpublished report, Forté Engineering Co., A Division of Forté-Fairbairn, Inc.

(4) Charles R. Kuehner, "Determination of Characteristics and Errors of the Forté Electronic Moisture Content Analyzer," unpublished report, Forté Engineering Co., A Division of Forté-Fairbairn, Inc.

(5) Charles R. Kuehner, "The Effect of Non-Uniform Moisture Distribution on Moisture Content Determination Made by the Forté Electronic Moisture Content Analyzer," unpublished report, Forté Engineering Co., A Division of Forté-Fairbain, Inc.

(6) Robert W. Colpitts, "The Effect of Sample pH on Moisture Determinations Made by Forté Electronic Moisture Content Analyzer," unpublished report, Forté Engineering Co., A Division of Forté-Fairbairn, Inc.

(7) S. L. Anderson, "The Air-Flow Method of Measuring Wool Fiber Fineness," *Journal of the Textile Inst.*, Vol. 45, No. 7, p. 312 (July, 1954).

(8) Robert H. Berg, "Determination of Particle Size Distribution by Examining Gravitational and Centrifugal Sedimentation According to the Pipet Method and With Divers," p. 143; "Electronic Size Analysis of Subsieve Particles by Flowing Through a Small Liquid Resistor," p. 245, Symposium on Particle Size Measurement, *ASTM STP No. 234*, Am. Soc. Testing Mats. (1958).

(9) "Method of Test for Fibre Length of Wool Tops with the Wool Industry Research Association's Fibre Length Meter," *Bulletin*, Wool Industry Research Assn. Vol. 21, No. 2 (April, 1959).

(10) "The Tippy Dyeing of Wool and Its control," AATCC, New York Section; *Am. Dyestuff Reptr.*, p. 486, (Sept. 8, 1947).

(11) Earnest Stead, "Solid Dyeings on Wool-Terylene Mixtures," (correspondence) *Journal*, Soc. Dyers and Colourists, Vol. 70, p. 355 (Aug., 1954).

(12) C. B. Jones and D. K. Mecham, "The Dispersion of Keratins. II Studies on the Digestion of Keratins by Reduction in Neutral Solutions of Protein Denaturants," *Arch. Biochem.*, Vol. 3, p. 193, (1943).

(13) K. Lees and F. F. Elsworth, "A Study of the Alkali Solubility Test for Determining the Degree of Fiber Damage in Wool," *Journal*, Soc. Dyers and Colourists, Vol. 68, No. 6, p. 207 (June, 1952); "Solubility of Wool in Urea-Bisulphite Solution," (correspondence) *Journal*, Soc. Dyers and Colourists, Vol. 70, p. 354 (1954).

(14) H. Kessler and H. Zahn, "A Relation Between Urea-Bisulfite Solubility and Disulfide Exchange in Wool, (correspondence) *Textile Research Journal*, Vol. 28, No. 4, p. 357 (April, 1958).

(15) J. B. Speakman, "The Future of Wool," *Proceedings*, International Wool Textile Research Conference, Australia, 1955, Vol. E, Part 2, E-545.

(16) M. Horio and T. Kondo, "Crimping of Wool Fibers," *Textile Research Journal*, Vol. 23, No. 6, p. 373 (1953).

(17) J. H. Dusenbury and J. Menkart, "The Present State of the Ortho- and Paracortex Concept," *Proceedings*, International Wool Textile Research Conference, Australia p. 142 (1955).

(18) R. D. B. Fraser and T. P. Macrae, "The Distribution of Ortho- and Para-Cortical Cells in Wool and Mohair," *Textile Research Journal*, Vol. 26, No. 8, p. 618 (Aug., 1956).

(19) H. Bogaty, D. Frishman, Arnold Sookne, and Milton Harris, "A Simple Quantitative Test for the Felting of Wool Top," *Textile Research Journal*, Vol. 20, No. 4, p. 270 (April, 1950).

Technical Note

Intercrystalline Cracking and Creep Rupture Life[1]

IN A STUDY of the influence of impurities on the creep and creep-rupture behavior of aluminum, Servi and Grant (**1, 2**)[2] observed that the log-log plots of stress versus time-to-rupture frequently produced two straight-line segments. They concluded that the points of inflection defined points of equicohesion between grains and grain boundaries at which the mechanism of fracture changed from transcrystalline (ductile) to intercrystalline (brittle). In an earlier paper (**3**) the author had concluded that similar points, noted in the log-log plots of stress versus time-to-rupture for certain steels, were attributable to an intercrystalline fracture mechanism. As additional evidence accumulates, however, it appears that these conclusions, which have been widely accepted, require re-examination. In particular, the evidence shows that the abrupt change in direction obtained when log stress is plotted against log time-to-rupture represents a special case of a much more general relationship; and that the influence of intercrystalline cracking on the shape of the curve is merely apparent and not real.

Figure 1 shows a plot of stress versus time-to-rupture, on log-log coordinates, of data from a high-purity aluminum alloyed with 0.17 per cent iron and creep-rupture tested at 365 C (690 F).

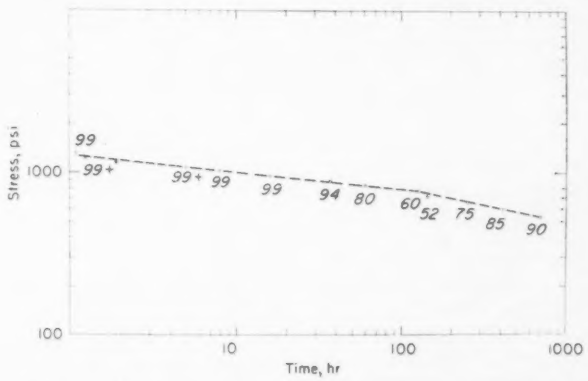


Fig. 1.—Aluminum with 0.17 per cent iron creep-rupture tested at 365 C (690 F).

[1] Published by permission of the director, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

The figures beside the recorded points represent the values for reduction of area of the fractured test specimens. Figure 2 illustrates the microstructure near the fracture of the specimen that broke with 52 per cent reduction of area. The causal relationship between the intercrystalline fissures and the change in slope of the straight line would appear to be established were it not for the increasing ductility of tests at decreasing stresses. In these tests the greater the reduction in area the less was the extent of intercrystalline cracking. It is therefore evident that any influence that the development of intercrystalline fissures may have on the slopes of the straight lines has been insignificant in these tests.

The minimum in the reduction in area of creep-rupture tests at intermediate times to failure, with increasing ductility at shorter and longer times as illustrated in Fig. 1, is not an unusual occurrence. McLean (**4**), referred to it in a discussion of intercrystalline fracture; Glen (**5**), illustrated an example of it in carbon-molybdenum steel; and Brown, *et al.* (**6**) showed that the same phenomenon has been found in a variety of heat-resisting steels and alloys. A most illuminating example is shown in Fig. 3, reproduced from a paper by Siegfried (**7**). The general development of intercrystalline brittleness in a tin-cadmium alloy, and the restoration of ductility at longer times to failure is beautifully illustrated.

The data of Fig. 3 have the great advantage that they include the stresses and times for rupture of each of the tests shown in the photograph. Fig. 4 is a graph obtained by plotting the logarithms of the stress against the logarithms of the times to rupture. No straight lines are found, no abrupt changes in the shape of the curve appear, and there is no indication that the intercrystalline brittleness shown by the specimens tested in the intermediate-stress range has exerted any influence whatever on the shape of the curve.

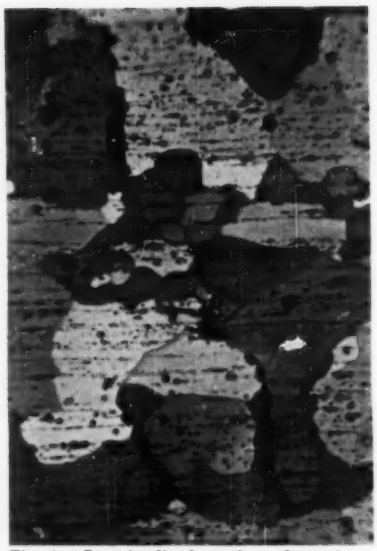


Fig. 2.—Longitudinal section of specimen with 52 per cent reduction in area. Anodized and photographed in polarized light (×100). Reduced one half in reproduction.

Creep-rupture brittleness under intermediate stresses, observed in two of the steels reported by Brown, *et al.* (**6**), prompted examination for a relationship with the stress versus time-to-rupture curves. Data from Figs. 3 and 4 of Brown's paper were replotted on log-log paper to give curves of stress versus time-to-rupture. No correlation was found between brittleness and time-to-rupture: the points appeared to lie on a smooth curve concave to the time axis, and again showed no indication of having been influenced by the mode of fracture of the test specimens. Finally, data for six steels obtained from *STP 180* (**8**) were plotted on log-log paper to show the relationship between stress and time-to-rupture. Here again all the points fitted smooth curves better than any converging straight lines that could be drawn.

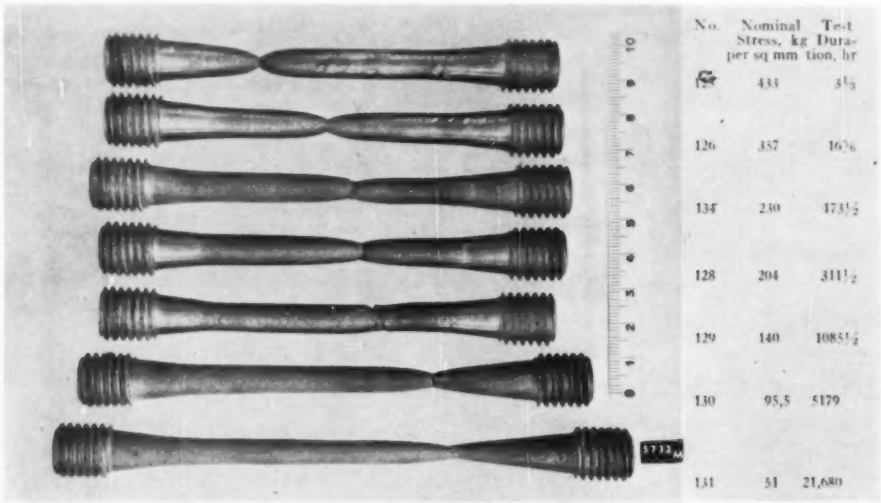


Fig. 3.—Creep-rupture fractured specimens of a tin-cadmium alloy from a paper by Siegfried (7).

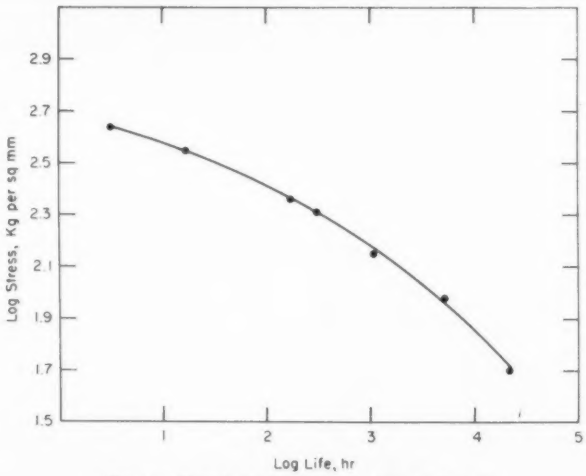


Fig. 4.—Graph obtained from data in Fig. 3.

Other things being equal, it is evident that development of intercrystalline fissures must shorten the life of a creep-rupture test. The insensitivity to the influence of intercrystalline cracking shown by the curves of Figs. 1 and 4, therefore, must indicate the concurrent operation of some strengthening influence. However, it is the purpose of this note to state the problem, rather than to suggest a solution. Many influences such as recrystallization, grain growth, precipitation, and effects of the atmosphere, affect the shape of the curve of log stress versus log time-to-rupture, and more needs to be learned about the operation of these and other effects before the reasons for the shape of any particular curve can be understood.

As a final comment, it may be said that the somewhat elusive property suggested by the term "equicohesion" appears to be as innocuous in these cases as intercrystalline cracking. The evidence seems to corroborate Gillett's judgment (9) that the concept of an equicohesive temperature is not useful in the solution of creep problems.

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REFERENCES

(1) I. S. Servi and N. J. Grant, "Creep and Stress-Rupture Behaviour of Aluminum as a Function of Purity," *Transactions*, Am. Inst. Mining and Metallurgical Engrs., Vol. 191, p. 916 (1951).
(2) I. S. Servi and N. J. Grant, "Structure Observations of Aluminum Deformed in Creep at Elevated Temperatures," *Ibid.*, p. 917.
(3) H. H. Bleakney, "Intercrystalline Cohesion and the Stress-Rupture Test," *Proceedings*, Am. Soc. Testing Mats., Vol. 47, p. 580 (1947).
(4) D. McLean, "Grain Boundaries in Metals," Oxford University Press, Amen House, London, p. 324 (1957).
(5) J. Glen, "Ductility in High-Temperature Rupture Tests," *Journal Iron and Steel Inst.*, Vol. 190, p. 34 (1958).
(6) W. F. Brown, Jr., M. H. Jones, and D. P. Newman, "Influence of Sharp Notches on the Stress-Rupture Characteristics of Several Heat-Resisting Alloys," Symposium on Strength and Ductility of Metals at Elevated Temperatures With Particular Reference to Effects of Notches and Metallurgical Changes, ASTM *STP No. 128*, Am. Soc. Testing Mats., pp. 25–45 (1952).
(7) W. Siegfried, "Investigations into the Influence of Notches on Creep Strength at High Temperatures," *Ibid.*, p. 103.
(8) Symposium on The Elevated Temperature Properties of Carbon Steels, Am. Soc. Testing Mats. (1955). (Issued as separate publication *ASTM STP* 180.)
(9) H. W. Gillett, "Some Things We Don't Know about the Creep of Metals," *Transactions*, Am. Inst. Mining and Metallurgical Engrs., Vol. 135, p. 31 (1939).

Influence of Particle-Size Distribution on Strength and Workability of Vibrated Mortar

By FRANCISCO GIULIANI and RAUL SUAREZ ROBLEDO

These tests show that, in the grading of sand, an improvement over the fineness modulus is the scheme of using two "nominal sieve openings," which, in the grading curve, correspond to the finer 10 and 60 per cent, according to Allen Hazen's definitions and extensive use in permeability and soil classification. The name of "effective sizes" may be properly generalized because of the influence of these nominal sieve openings on the permeability of sands and on the properties of concrete.

Use of a chart with these effective sizes as coordinates of grading is proved to be an efficient way to represent each measurable property of the concrete with respect to the grading of sand.

MODERN methods for the design of concrete mixtures take into consideration the particle-size distribution of the aggregate, because of the effects of grading on the workability of the fresh concrete and on the density and strength of the hardened concrete. In practice, grading is based on grain-size determination with standard sieves, and recommended grading limits are given separately for sand and gravel, which for this purpose are defined as the fraction of the aggregate passing or retained on sieve No. 4.

If it is assumed that both sand and gravel meet the specifications, the design of concrete mixtures usually starts from the following characteristics of grading: maximum sieve opening, percentage of sand in the aggregate, and fineness modulus of the sand. The fineness modulus, computed by adding the cumulative percentages retained in standard sieves Nos. 4 to 100 and dividing by 100, is in fact only a number representing the area between the grading curve and both axes of coordinates. It is generally recognized that such a number cannot be relied upon entirely as proof that a sand is within certain grading limits.

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Obviously it should be a great advantage to represent by a more reliable method the grading of sand with enough approximation to make possible direct numerical relationships between each grading curve and each measurable property or characteristic of the concrete. To this end, the authors have made a number of tests, planned to correlate characteristics of mortars and grading of sand. Values of these characteristics and properties will be represented in a special chart, taking as coordinates of grading the nominal sieve openings obtained from the size-distribution curves for the finer 10 and 60 per cent. To this purpose, a logarithmic scale is used, for sieve openings in millimeters, in the diagram of particle-size distribution.

These nominal openings at 10 and 60 per cent have been proposed by Allen Hazen,[1] the first as an "effective size," and their ratio as a "coefficient of uniformity," both widely used in papers on permeability of sand and soil classifi-

[1] "Low Dams," National Resources Committee, Washington, D. C., 1938, p. 242.

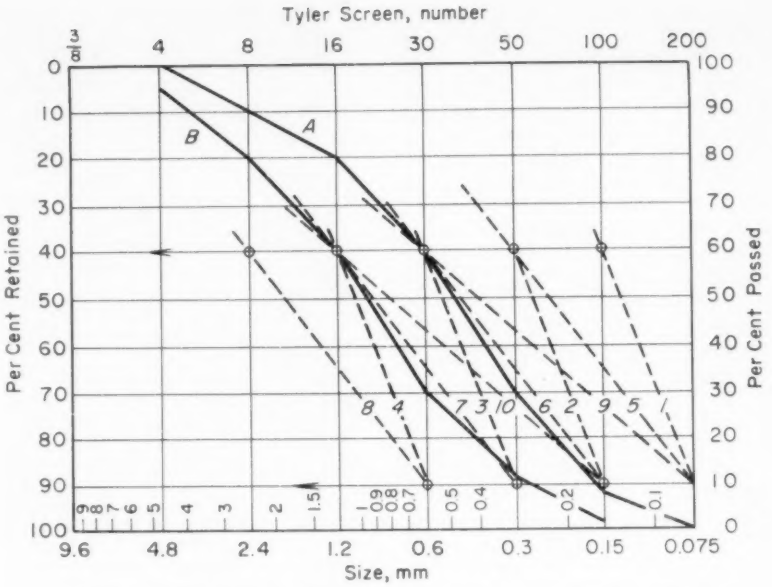
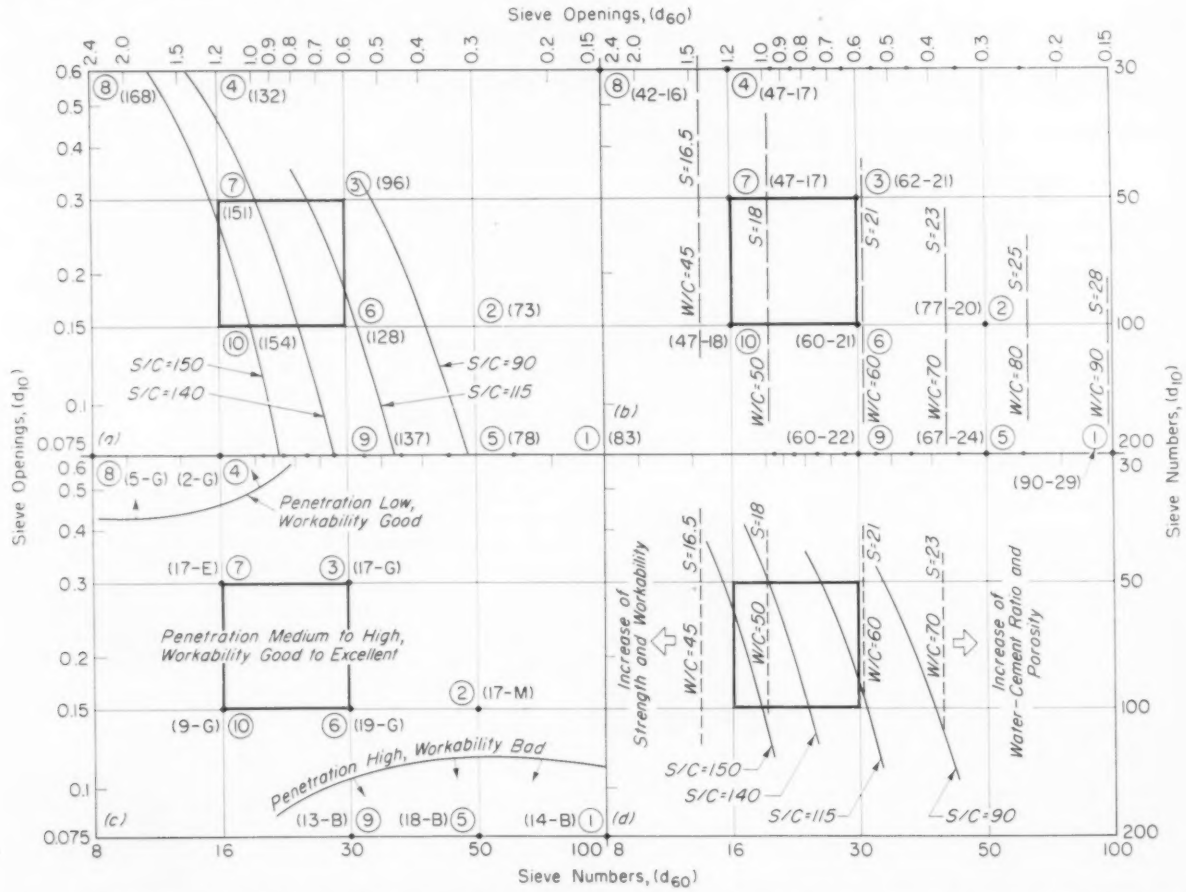


Fig. 1.—Sand-grading limits specified by the U. S. Bureau of Reclamation.



Numbers in circles designate sand gradings represented by coordinates d_{10} and d_{60}. Square 3-7-10-6 encloses gradings inside specifications of U. S. Bureau of Reclamation. Numbers in parentheses represent strength relative to cement content (*a*) and water-cement ratio and effective porosity (*b*). Numbers and letter in parentheses represent penetration and judgment on workability in terms of bad, medium, good, and excellent (*c*). Curves represent constant S/C (*a*) and constant W/C and s (*b*). The curves and values in (*d*) are approximate for the field of good workability and are based on judgment and penetration test.

Fig. 2.—Proposed representation of grading characteristics.

cation. We shall refer to them in this paper as "effective sizes" d_{10} and d_{60}. Each measured or computed property or characteristic, represented in the chart for each set of effective sizes as coordinates of grading, will show to what extent it may be possible and convenient to substitute the effective sizes for the fineness modulus in the design of concrete mixtures.

Gradings Selected

In Fig. 1 the curves *A* and *B* represent the limits of grading for sands specified by the U. S. Bureau of Reclamation. Their fineness moduli are 2.3 and 3.2, but if we have a detailed logarithmic scale for sieve openings, it is easy to determine the effective sizes, d_{10} and d_{60}. They are 0.16 and 0.60 mm for curve A; and 0.27 and 1.2 mm for curve B. Also, a number of particle-size distibution curves have been selected for the tests, with different sets of values d_{10} and d_{60}, which define straight lines in the usual diagram of grading, and points in the new proposed chart. In Table I each selected grading is properly described in percentages retained in sieves Nos. 4 to 200 and is identified with an arbitrary number or letter and by effective size, fineness modulus, and coefficient of uniformity. Numbers allow a quicker correlation and identification of grading in Table I, in the ordinary grading diagram of Fig. 1, and in the proposed chart in Fig. 2. Notice that the field of recommended gradings, between curves *A* and *B* in Fig. 1, has a corresponding field in a square between points 3, 7, 10, and 6 in Fig. 2 and that properties of mortar have been obtained for gradings inside and outside these fields.

Characteristics of Materials

The characteristics of the materials used in the tests reported in this paper have been carefully determined, for the sake of correlation with similar work and checking in the future:

TABLE I.—SELECTED PARTICLE-SIZE DISTRIBUTIONS.

Grading Number	Per cent Retained in Sieves							Residue	Fineness Modulus	Effective Size		Uniformity Coefficient
	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200			d_{10}	d_{60}	
1	..	..	..	..	..	40	50	10	0.4	0.075	0.15	2
2	..	..	..	..	40	50	10	..	1.3	0.15	0.30	2
3	..	..	..	40	50	10	..	..	2.3	0.30	0.60	2
4	..	..	40	50	10	..	..	..	3.3	0.60	1.20	2
5	..	..	..	16	24	25	25	10	1.2	0.075	0.30	4
6	..	..	16	24	25	25	10	..	2.1	0.15	0.60	4
7	..	16	24	25	25	10	..	..	3.1	0.30	1.20	4
8	16	24	25	25	10	..	..	..	4.1	0.60	2.40	4
9	..	8	16	16	17	16	17	10	2.0	0.075	0.60	8
10	8	16	16	17	16	17	10	..	2.9	0.15	1.20	8
A	0	10	10	20	30	22	8	..	2.3	0.16	0.60	3.75
B	5	15	20	30	18	10	2	..	3.2	0.27	1.20	4.45

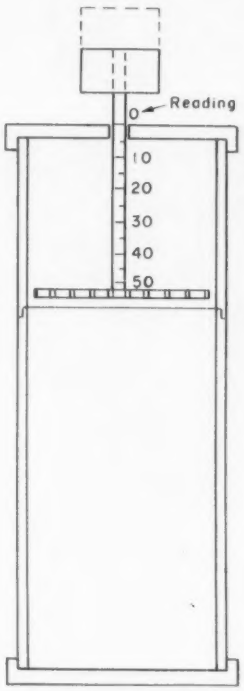


Fig. 3.—Cylinder with adjustable upper section, cover, and stem.

1. Standard cement from Mendoza (Argentina) according to official specifications OSN and IRAM in this country. Tests in 1:3 mortar with quartzitic sand: compressive and tensile strength at 28 days, 580 and 40 kg per sq cm (8250 and 540 psi).

2. Natural stream sand, clean, specific gravity 2.65, no appreciable amount of mica, clay, and calcareous particles. Composition: 28 per cent quartz and 20 per cent feldspar. Shape of particles: 35 per cent angular, 41 per cent subangular, and 24 per cent rounded.

Independent Variables and Constants

In order to determine strength, porosity, and workability for different gradings of the sand, each grading was made by weighing every fraction between standard sieves, according to data in Table I, for the exact weight of sand, and adding the exact weight of cement for each specimen.

Each batch was just enough to fill one mold. Water was poured from a graduate and measured until a state of minimum plasticity was obtained, so as to make it possible to manipulate into the mold and to compact by vibration. Another specimen was made by the same procedure, with water added and measured until a state of maximum plasticity was obtained, it still being

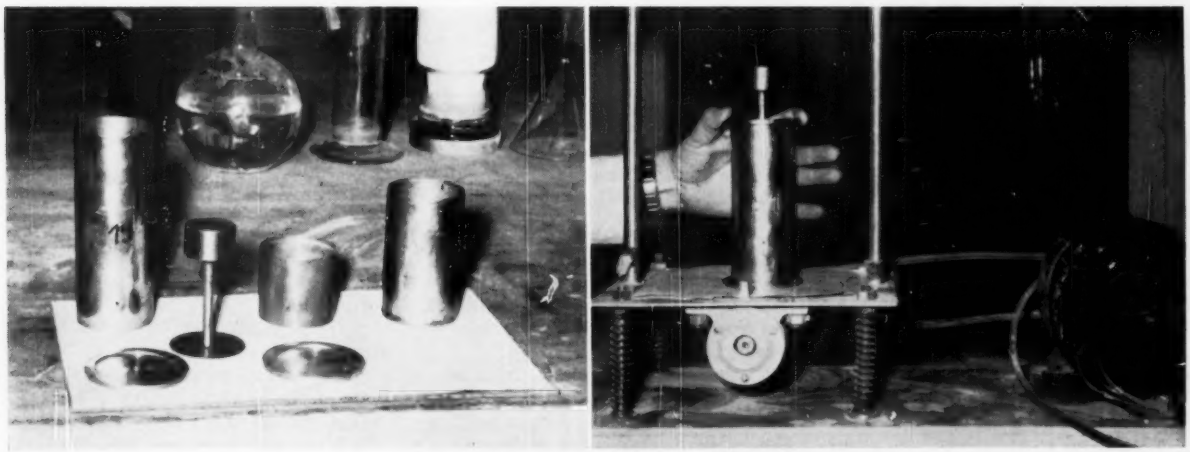


Fig. 4.—Forms, parts, and vibration setup.

possible to manipulate and compact the specimen. For each particle-size distribution nine specimens were made; three for each of the maximum, minimum, and medium water content, in the range that we designate now as "water-plasticity" conditions.

There are then, in these tests, two independent variables represented by the grading of the sand and the water-plasticity conditions, and a constant represented by the proportion, 1:3, of cement to sand by weight.

Measurements

The tests have been chosen and studied, and the equipment designed, so that every measurement may be made directly on each specimen and without delay, according to the following procedure:

1. The volume of each batch after compaction is placed in special 2 by 4 in. cylinders, provided with an adjustable upper section 2 in. high, with a base and a cover with a hole through which slides a stem connecting a perforated circular plate, as shown in Figs. 3 and 4. Each batch is manipulated into the mold, the cover is properly adjusted, setting the perforated disk on the top of the slightly compacted mixture, and the set, ready for compaction, is subjected to vibration, as shown in Fig. 4. The stem carries a scale for direct and exact reading of volume.

2. Penetration is measured with a circular plate of $^3/_4$ in. diameter, loaded for a pressure of 0.5 kg per sq cm (7 psi), as shown in Fig. 5, on the straight-edged top of the specimen after removal of the top section of the mold. This test has been compared with slump and flow tests at different water contents with sand averaging gradings A and B in 1:3 mortar. The curve *Ia* in Fig. 6 shows the variation of slump with water-cement ratio in tests made with a mold of 4 by 2 in. diameter and 2 in. high. The curves *Ib* and *Ic* show the results of settlement in flow tests with the same mold for 5 and 10 strokes $^1/_2$ in. high. Curve II shows penetration. The sensibility of the penetration test and the possibility to perform it directly on the straight-edged top of the specimen which is only slightly disturbed by the test, have been the factors decisive in the adoption of this test for measuring workability.

3. The contraction of the hardened specimen at 24 hr is measured with a dial gage as shown in Fig. 5. Unit or specific contraction is computed in per cent of the height of the specimen.

4. For testing strength at 28 days, specimens are removed from the molds with a jack after 24 hr and kept in the humid room at 20 C on flat pans with $^1/_4$ in. of water to insure saturation by capillarity and condensation. As the molds are slightly conic for easy removal of specimens, it is possible to make strength and permeability tests on the same specimens.

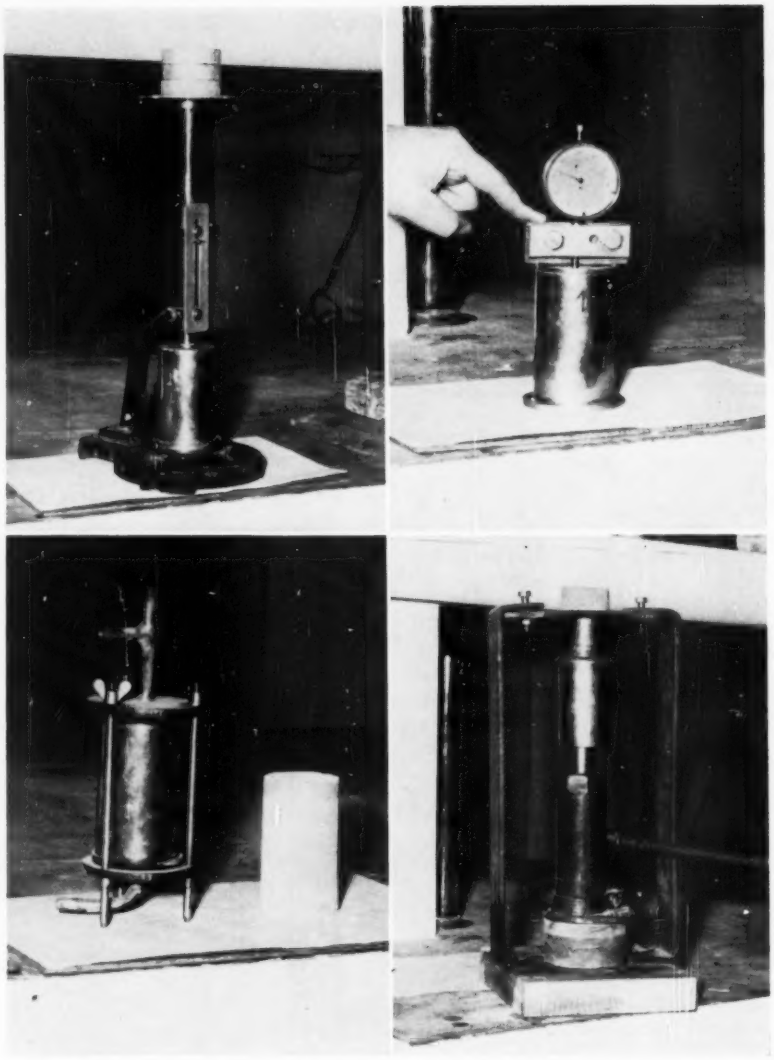


Fig. 5.—Measurement of penetration, workability, and contraction of hardened specimen, permeability set and removal of specimen.

Characteristics and Properties

Characteristics and properties of mortars for each grading of sand and each of the three water-plasticity conditions (see Independent Variables and Constants) are measured or computed and given in Table II as follows:

1. Water-cement ratio by weight for each batch, obtained from the volume of water measured in the graduate (see Independent Variables and Constants) and from the given constant weight of cement.

2. Porosity determined from the volume of the compacted batch (see Measurements, 1), the constant weights of cement and sand (see Independent Variables and Constants) and the densities of these materials (sp gr 3.15 and 2.65). Porosity is defined for the fresh mortar compacted as the ratio of volume minus the volume of solids to total volume.

3. Penetration as a measure of plasticity and workability (see Measurements, 2).

4. Workability, as a direct observation in the manipulation of the batch, in relative terms of bad, medium, good, excellent (B,M,G,E). Both penetration and direct observation of workability had to be considered together, because of the inaccuracy of the penetration test and of any other plasticity test for concrete.

5. Unit contraction of the hardened specimen (see Measurements, 3).

6. Cement content determined as a ratio of the constant weight of cement to the volume of the hardened mortar, which is computed from the volume of the compacted batch (see Measure-

ments, independent Variables and Constants) and the unit contraction.

7. Strength at 28 days.

8. Effective porosity, determined as a ratio of the volume of water in the specimen coming out of the humid room (see Measurements, 4) to the volume of the specimen.

Results and Charts

Results are given in Table II in four separate sections—one for each of the three maximum, medium, and minimum water-plasticity conditions (see Independent Variables and Constants) and the last for the general averages of the most representative characteristics in the range of water-plasticity conditions. Such averages, as final results, have been represented in charts (Fig. 2) to show the variation of properties with the grading of the sand, represented by the effective sizes, d_{10} and d_{60}:

1. In Fig. 2(a) is represented each value obtained for strength relative to cement content, corresponding to each set of coordinates of the grading of the sand. Curves drawn approximately at constant S/C (strength-cement ratio) values show clearly that strength is a function of d_{60} and is only slightly influenced by d_{10}.

2. In Fig. 2(b) is represented each value obtained as average water-cement ratio, W/C, and each average effective porosity, s, corresponding to each set of coordinates of the grading of the sand. Curves drawn at constant W/C and s values show that these characteristics are both functions of d_{60}, and are not influenced by d_{10}. Obviously there is a linear relationship between W/C and s values

3. In Fig. 2(c) is represented each average of penetration, and each letter qualifying workability, corresponding to each set of coordinates of the grading of the sand. Values are not sufficiently consistent in this case to allow drawing of curves, but it is possible to separate three areas or fields of different behavior: the lower section of the chart, which corresponds to high values of penetration and workability, is judged as bad; in the upper section penetration is low and workability is judged good; only in the central section, just about the area of recommended gradings, is there the expected agreement between high values of penetration and good workability. Obviously, penetration is not sufficiently representative of workability, but there is sufficient evidence that we obtain workable mixtures for d_{60} larger than 0.5 mm and d_{10} larger than 0.1 mm.

Conclusions

From the results of tests listed in Table II and from the interpretation of charts in Figs. 2(a), (b), and (c), which

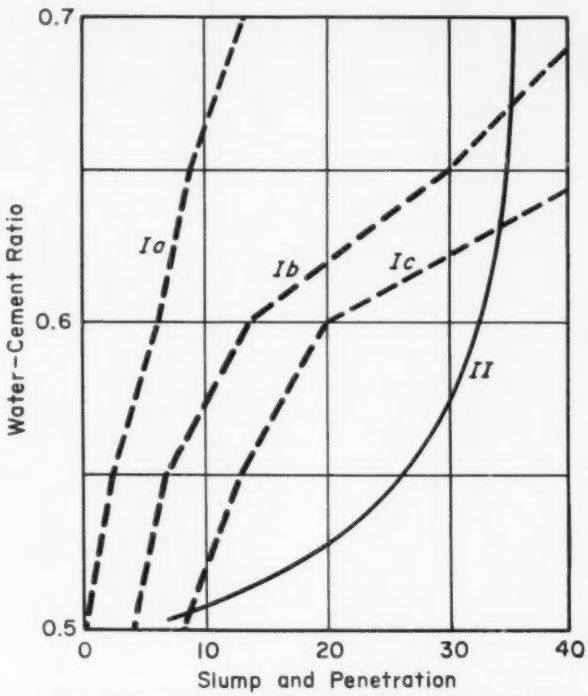


Fig. 6.—Water-cement ratio versus slump and penetration.

TABLE II.—EFFECT OF PARTICLE-SIZE DISTRIBUTION ON PROPERTIES OF VIBRATED MORTAR.

NOTE.—Ratio of sand to cement is 3:1 by weight. Strength according to standard specifications for cement 580 kg per sq cm. (8250 psi).

PARTICLE-SIZE DISTRIBUTION										
Number	1	2	3	4	5	6	7	8	9	10
Fineness Modulus	0.4	1.3	2.3	3.3	1.2	2.1	3.1	4.1	2.0	2.9
d_{10}	0.075	0.15	0.30	0.60	0.075	0.15	0.30	0.60	0.075	0.15
d_{60}	0.15	0.30	0.60	1.20	0.30	0.60	1.20	2.40	0.60	1.20
Uniformity coefficient	2	2	2	2	4	4	4	4	8	8
MAXIMUM WATER-PLASTICITY CONDITIONS										
Water-cement ratio	1.00	0.90	0.70	0.55	0.80	0.70	0.55	0.50	0.70	0.55
Porosity	0.38	0.33	0.30	0.25	0.35	0.31	0.26	0.22	0.31	0.25
Penetration, mm	19	38	18	6	40	40	40	10	19	14
Workability[a]	B	M	G	G	B	G	E	G	B	B
Contraction, per cent	3.5	2.7	1.4	0.5	2.0	3.2	3.0	1.4	2.8	2.5
Cement content, lb per cu ft	27.6	30.0	30.9	32.6	28.9	35.0	30.8	34.0	31.2	33.2
Strength, 28 days, psi	2130	1860	2620	3940	2450	3260	4350	5180	3840	4780
Effective porosity[b]	0.30	0.22	0.22	0.19	0.28	0.24	0.19	0.19	0.25	0.20
MINIMUM WATER-PLASTICITY CONDITIONS										
Water-cement ratio	0.80	0.55	0.55	0.40	0.55	0.50	0.40	0.35	0.50	0.40
Porosity	0.36	0.34	0.29	0.26	0.33	0.27	0.22	0.20	0.28	0.23
Penetration, mm	7	1	2	0	1	2	1	0	2	1
Workability[a]	B	B	G	G	B	G	E	M	B	M
Contraction, per cent	0.6	0.6	0.2	0.2	0.1	0.5	0.3	0.8	0.3	0.1
Cement content, lb per cu ft	27.8	28.8	30.3	31.7	28.8	31.2	31.1	34.5	31.2	33.4
Strength, 28 days, psi	2390	2340	3240	4050	2720	4540	5280	7150	4360	4530
Effective porosity[b]	0.26	0.19	0.20	0.16	0.20	0.18	0.15	0.14	0.18	0.16
MEDIUM WATER-PLASTICITY CONDITIONS										
Water-cement ratio	0.90	0.80	0.60	0.45	0.70	0.60	0.50	0.40	0.60	0.50
Porosity	0.37	0.33	0.29	0.24	0.33	0.28	0.26	0.21	0.29	0.24
Penetration, mm	16	13	4	1	14	15	10	5	17	11
Workability[a]	B	M	G	G	B	G	E	G	B	G
Contraction, per cent	2.1	1.4	0.6	0.4	1.1	0.9	1.8	1.2	1.9	2.0
Cement content, lb per cu ft	28.0	29.4	30.4	32.6	28.0	29.6	31.0	32.6	28.6	30.6
Strength, 28 days, psi	2390	2240	2990	4850	2870	4100	4620	6320	4700	5670
Effective porosity[b]	0.30	0.19	0.21	0.17	0.25	0.22	0.17	0.15	0.22	0.19
AVERAGE WATER-PLASTICITY CONDITIONS										
Water-cement ratio	0.90	0.77	0.62	0.47	0.67	0.60	0.47	0.42	0.60	0.47
Effective porosity[b]	0.29	0.20	0.21	0.17	0.24	0.21	0.17	0.16	0.22	0.18
Workability[a]	B	M	G	G	B	G	E	G	B	G
Strength-cement ratio, psi per lb per cu ft	83	73	96	132	78	128	151	168	137	154
Penetration, mm	14	17	17	2	18	19	17	5	13	9

[a] In relative terms of bad, medium, good, and excellent.
[b] Voids equivalent to water content in saturated specimen.

are summarized in the chart of Fig. 2(*d*) for the area of workable mixtures, we may draw the following conclusions:

1. Grading or particle-size distribution of the sand is not sufficiently or completely determined by the fineness modulus. Thus, it is not advisable to use it, at least not alone, as a number representative of the gradation of the sand for the design of concrete mixtures.

2. Gradings of sand may be represented easily and accurately, without ambiguity, by the two effective sizes, d_{10} and d_{60}.

3. Properties of the mortar influenced by the grading of the sand may be clearly represented in charts as functions of grading represented by the effective sizes as coordinates.

4. With data obtained only for different gradings of natural stream sand, it has been found that the strength-cement ratio, S/C, increases with an increase of the effective size d_{60}, and, not so conspicuously, with an increase of the coefficient of uniformity or ratio d_{60}/d_{10}. Further, both the water-cement ratio, W/C, and the porosity decrease as the value of d_{60} increases; and workability is good for d_{60} higher than 0.5 mm and d_{10} higher than 0.1 mm. Obviously, some well-known facts in concrete technology are confirmed; for example, strength and density of the concrete increase when the water-cement ratio decreases, and the water-cement ratio necessarily increases for finer and more uniform sand.

5. Further research is necessary to obtain similar data for sands of different origin, mineral composition, and particle shape, varying also the proportion of cement to sand in order to substitute the use of the effective sizes for the fineness modulus in the design of concrete mixtures. This paper gives only the information available at this moment, which seems enough to prove the advantages inferable from such substitution.

Another fact, independent of the tests and results reported in this paper, is that the fineness modulus is closely related to the value d_{60} and practically not influenced by the value d_{10}, as we can see in Table I, so that we may infer that the value d_{60} makes a pivot for the grain-size distribution curves, which have all about the same fineness modulus, corresponding to about the same area with the axes of coordinates, but have different coefficients of uniformity, corresponding to the different slopes of such curves. From this fact we may draw two additional conclusions:

6. The fineness modulus and the effective size d_{60} are directly related, but neither of them defines sufficiently or without ambiguity the grain-size distribution curve.

7. Either the set of values d_{60} and d_{10} or the set of values for fineness modulus and uniformity coefficient may be chosen to represent sufficiently a grain-size distribution curve, but the values of the effective sizes are easier to represent and they should be necessary to determine the uniformity coefficient.

Electromagnetic Determination of Nickel Thickness for Re-entry Vehicle Heat Sinks*

By S. A. LoPILATO and C. H. HASTINGS

The increasing demand for high quality and precision in the missile field has created many unique and interesting problems in nondestructive testing.

The problem of accurately measuring nickel coatings up to 12 mils thick electrodeposited on heat-sink copper is described. This required special consideration in eddy-current instrumentation, measuring technique, and reference standards. The test that was developed was used to control metallurgical and electroforming variables during fabrication. Processing variations which influenced the test results are also described.

THE MATERIALS used in heat sinks for ICBM re-entry vehicles are chosen for their high thermal conductivity and high chemical purity. During re-entry, the heat-sink surface is subjected to extremely high temperatures, which are reduced by conduction and dissipation of heat. These processes prevent re-entry vehicle burnout, and allow the internal components to function properly.

In one early heat-sink design, nickel was electrodeposited on high-purity copper. The nickel thickness was required to be uniform over the entire surface of the heat sink. Nickel was chosen for its high reflectivity, oxidation resistance, and melting point (2645 F).

Figure 1 shows a full-scale, early re-entry (heat-sink) vehicle developed by Avco Research and Advanced Development Div. (RAD).

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C. H. HASTINGS is leader of the Nondestructive Test Development Group, Materials Dept., Avco Research and Development Center, Wilmington, Mass. Following 17 years in research and development of nondestructive tests at Watertown Arsenal, he joined the staff at Avco as a senior staff scientist in 1957. Since then, his work has involved nondestructive test methods and control techniques for many materials, including metals, plastics, ceramics, and composites. He is active as a member and vice-chairman of ASTM Committee E-7 on Nondestructive Testing, and is a past national president of the Society for Nondestructive Testing.

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Fig. 1.—Full-scale heat-sink re-entry vehicle.

Definition of Nondestructive Testing Problem

Early in the heat-sink development program, it was determined that nickel thickness was to be approximately 0.006 ± 0.002 in., deposited by the plating process. The heat-sink was 63 in. in diameter, with a compound curvature (see Fig. 2). Nickel surface-finish requirements, after final polishing, would be approximately 20 to 50 microinches peak-to-valley. It was pointed out that the surface could not be scratched during final nondestructive testing.

Electromagnetic Test Parameters

The electromagnetic (eddy-current) test principle is based on the phenomenon that a conductor, when brought into the field of a coil excited by an alternating current, has induced in it spatially distributed eddy currents that circulate in closed loops. The relationship between the reflected impedance seen by a probe coil and the properties of the composite conductor (nickel on copper) is complex. However, it has been established that changes in coating thickness are detectable if the eddy-current penetration depth is greater than the coating thickness, and also, if the base and coating differ in resistivity or magnetic permeability. The penetration depth is the depth at which eddy-current density is approximately 37 per cent of its surface value.

For the heat-sink application, the required penetration depth was approximately 0.012 in. for good test sensitivity. For this penetration, the required frequency for coil excitation is calculated from:

$$\delta = \frac{3.5}{\sqrt{f}} \sqrt{\frac{\rho}{\mu_{rel}\,\rho_0}} \qquad \ldots\ldots(1)$$

where:

δ = depth of penetration = 0.012 in.,
f = exciting frequency, cps,
ρ/ρ_0 = ratio of the resistivity of nickel to that of copper = 4.1, and
μ_{rel} = relative permeability of nickel = 110.

Substituting these values into Eq 1 gives f = 3000 cps. At this frequency, some of the eddy currents circulate in the base metal (copper).

Test Equipment

A survey of various electromagnetic equipment manufacturers revealed that all available instruments were designed for nickel thicknesses not exceeding 0.001 in. and operated at too high a frequency for the existing problem. A manufacturer was therefore engaged to build an instrument to the following specifications:

1. Nickel thickness range and accuracy:
   (*a*) 0.001 through 0.003 in., ±15 per cent.
   (*b*) 0.003 through 0.008 in., ±10 per cent.
   (*c*) 0.008 through 0.010 in., ±15 per cent.
2. Base metal properties (copper):
   (*a*) thickness in excess of 0.250 in.
   (*b*) conductivity from 99 to 102 per cent of International Annealed Copper Standard (IACS).
3. Instrument response must be based upon standard reference samples of known thickness to be supplied by Avco RAD.
4. The nickel coating to be measured may be in a highly polished condition, and special effort in probe construction should be made to avoid scratching or otherwise marring the surface finish in the process of making a measurement.
5. The instrument must be portable and employ a measuring probe approximately 1 in. in diameter which can be manually operated at least 6 ft from the instrument.

Nickel Thickness Standards

Reference specimens simulating heat-sink nickel plating as to shape, finish, metallurgical properties, and nickel thickness range, were fabricated by the Nondestructive Test Development Group at Avco RAD.

Five flat copper pieces 3 by 6 in. and $\frac{1}{4}$ in. thick were used as the base material. Sufficient plating area was required to obtain uniform nickel-thickness buildup over a $1\frac{1}{2}$-in. square area. The copper specimens were first heat-treated at 700 F in an inert atmosphere for 1 hr, then surface-ground to the required flatness and parallelism. Specimen thickness was next measured to 0.0001 in., using a precision micrometer. The conductivity of each copper specimen was determined (approximately 102 per cent IACS). Samples were then nickel-plated with enough buildup

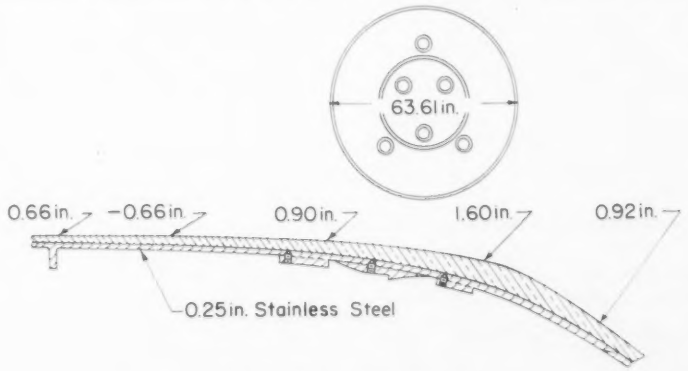


Fig. 2.—Heat-sink geometry.

Fig. 3.—Nickel thickness gage.

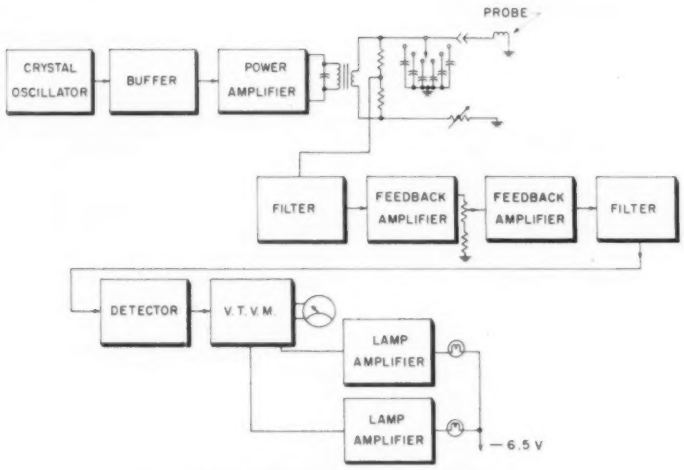


Fig. 4.—Block diagram of nickel thickness tester.

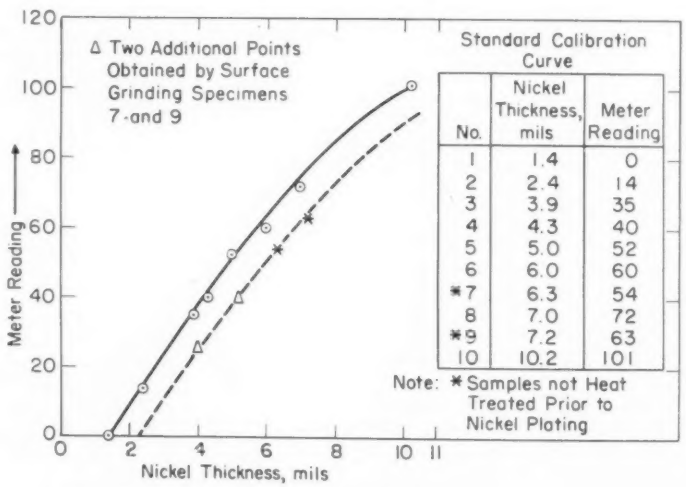
to permit subsequent surface grinding to the desired nickel thicknesses. Samples were cut in half and surface-ground using extreme caution to maintain flatness, parallelism, and to minimize surface stresses. The ten specimens were next highly polished to simulate a heat-sink surface, and remeasured to an accuracy of 0.0001 in. Half of each specimen was used for destructive determinations of nickel thickness; the other half was used as a reference for checking electromagnetic gage performance.

Gage Description and Operation

The thickness gage developed is a transistorized, battery-powered, portable instrument (Fig. 3). In addition to the 1-in. diameter probe, a $\frac{3}{4}$-in. diameter probe is available to detect and measure small-area variations in thickness or physical properties. Both probes are faced with Teflon to prevent scratching the polished nickel.

When the probe is placed firmly against the nickel layer, the electrical impedance of the coil inside the probe is changed. The probe coil constitutes one leg of an impedance bridge having suitable balancing condensers and resistors in the other legs of the bridge. Impedance changes are shown on the instrument meter, giving a measure of the nickel thickness. The bridge is adjusted to give optimum linearity of thickness indication. The principles of operation of such gages have been discussed in detail elsewhere.[1] A 0.001-in. change in nickel thickness is readily discernible over the desired thickness range. Alarm lamps are provided to indicate when the meter has deflected over some preset percentage of its scale. These lamps can be adjusted so that the instrument can be used in a go, no-go application. A block diagram of the gage is shown in Fig. 4.

A calibration curve, shown as the solid curve in Fig. 5, was plotted using the ten reference specimens. The calibration points for two specimens (7 and 9) were off the curve established by the other eight specimens. These two specimens were not heat-treated prior to nickel plating. This was done intentionally, to determine what effect this might have on calibration. Specimens 7 and 9 were again surface-ground with extreme care to eliminate surface stresses or discontinuities and to establish two new nickel-thickness points. The new points (open triangles in Fig. 5) followed a curve displaced from but similar to the standard calibration curve. No significant differences of conductivity occurred in the copper before or after heat treatment. Limited



No.	Nickel Thickness, mils	Meter Reading
1	1.4	0
2	2.4	14
3	3.9	35
4	4.3	40
5	5.0	52
6	6.0	60
*7	6.3	54
8	7.0	72
*9	7.2	63
10	10.2	101

Fig. 5.—Standard calibration curve.

[1] *Nondestructive Testing Handbook*, edited by R. C. McMaster, "Eddy Current Test Equipment," Vol. II, Sec. 40, Ronald Press, New York, N. Y., Oct., 1959.

destructive analysis performed on specimens 7 and 9 were inconclusive in determining reasons for these shifts. It was assumed that the stresses in the nickel (affecting conductivity or permeability or both), as a result of not heat treating the copper, was responsible for the shift in instrument response on these specimens.

This is a good illustration of the fact that a process or design change can upset electromagnetic test equipment response. The equipment user must anticipate and control such changes whenever possible.

Nondestructive-Destructive Test Correlation

During the early heat-sink development stages, variations in design and process were evaluated. The electromagnetic gage was used effectively during this development activity on full-scale heat sinks. In addition, destructive studies were made to correlate the actual nickel thickness with that determined by nondestructive measurement.

As a result of these studies, anode placement and masking adjustments were made to achieve the required nickel-thickness distribution over the entire heat-sink surface. It was confirmed also that the influence of heat-sink surface contour on thickness gage readings could be neglected. Because of the large radius, no difference could be found between thickness measurements on curved and flat specimens.

Nickel thicknesses as determined by destructive means and by the electromagnetic gage measurements were not always in agreement, however. Variations in the electroplating process that might have accounted for the shifts in the standard calibration curve were investigated. Although considerable plating variables were suspected, effort to establish some control on those processing variables proved unsuccessful. It appeared that placing strict controls on the electroplating process would be more troublesome than correcting the calibration curve for the electromagnetic gage. Destructive correlation studies between thickness gage readings and actual nickel thickness yielded a family of curves, which represented the range of variation in the nickel-plating process.

Process Control Specimens

To prepare a calibration curve specific for each heat sink, copper control specimens were used. Accurately machined and heat-treated copper specimens were placed in each heat-sink nickel-plating bath. By controlling the the amount of plating on each specimen, three different nickel-thickness calibration points were obtained. The actual nickel thickness was then determined to within ±0.0001 in. This resulted in known thickness standards for each heat sink and established the proper curve for reliable thickness determination. In subsequent destructive studies, this technique of monitoring process variation by the use of control specimens proved successful.

Because of nickel-electroplating variations, the ten reference standards previously described were useful only for checking gage adjustment and conformity to the generalized calibration curve.

Nickel Thickness Measurements

A typical inspection of a full-scale heat sink is shown in Fig. 6. Thickness measurements were made at the plating facility, and test results were available in 20 or 30 min. Instrument sensitivity, balance (both resistance and capacitance), and a thickness calibration curve were recorded for each part inspected. This was accomplished by using the thickness standards prior to each inspection. An inspection log (Fig. 7) is kept for each heat sink, indicating test procedure and test results, and applying a constant correction factor obtained from the control specimens plated with each heat sink. Instrument calibration is checked frequently during each part inspection to compensate for drift.

Fig. 6.—Typical full-scale heat-sink inspection.

Conclusions

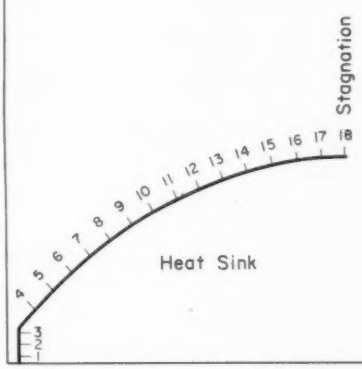
Thickness determination by the electromagnetic (eddy-current) test principle of nickel electrodeposited on copper proved successful up to unusual thicknesses. The success of the effort depended on a number of factors: (1) The problem was clearly defined early in the heat-sink development program. This allowed sufficient lead time to conduct a realistic nondestructive-destructive test correlation, (2) The choice was made of a well-established test principle which was ideally suited to the problem, (3) By defining the areas of responsibility, a thickness gage was obtained quickly and economically, and (4) a close relationship was maintained with design and process engineering. The monitoring of changes in problem parameters, which could affect the nondestructive test development program, was made possible by this liaison. In some instances, tentative design or process requirements were revised to satisfy nondestructive test considerations.

Acknowledgment:

The contributions of D. C. Erdman and R. Hochschild of Metrol, Inc., Pasadena, Calif., in the design and construction of the thickness gage are gratefully acknowledged.

Nickel Thickness Readings

Instrument: Nickel Thickness Gage No. T2-ST-102
Large Probe: Sensitivity on 3
"R" Balance on 5
"C" Balance on H
Readings: 18 Total for Each Quadrant
(N-S-E-W) 2 in. Apart



	N	S	E	W	Average Nickel Thickness, mils
1	98	96	98	78	9.8
2	78	77	78	77	7.45
3	74	73	73	73	7.0
4	74	73	73	73	7.0
5	80	80	78	76	7.55
6	84	82	82	82	7.9
7	84	82	82	80	7.9
8	84	82	82	80	7.9
9	86	85	85	83	8.2
10	86	84	84	84	8.2
11	82	80	83	82	7.9
12	82	80	80	80	7.7
13	82	80	80	80	7.7
14	82	82	82	81	7.9
15	83	82	82	81	7.9
16	82	78	80	78	7.65
17	80	75	76	76	7.3
18	74	74	74	74	7.0

Note: Nickel Thickness Readings Taken From Standard Calibration Curve

Fig. 7.—Typical inspection log.

Apparatus for Hardness Testing at Low Temperatures

By L. L. FRANCE, R. T. BEGLEY, and H. KOHUTE

THE NEED FOR information on the temperature dependence of the strength of materials at low temperatures has been increasing for a number of years. This information is necessary for low-temperature service applications and for fundamental studies of flow and fracture behavior. While investigations of this type can best be done by conventional tension or compression testing, such testing programs are frequently impractical. In the early stages of alloy development programs, for example, the amount of material available is often insufficient for an extensive testing program.

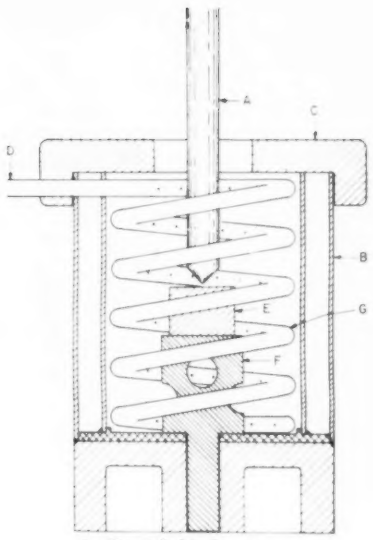
Low-temperature hardness measurements supply data that can be correlated with the mechanical strength at these low temperatures. Several previous investigators (**1,2,3**)[1] have made low-temperature hardness measurements; however, they were limited to temperatures obtainable by the use of liquid baths. Since there are no liquids readily available having a boiling point high enough or a freezing point low enough to cover the temperature range from −160 to −196 C, this range is difficult to investigate.

Description of Apparatus

The equipment described in this paper was constructed to overcome the disadvantages normally encountered with the use of low-temperature baths, particularly the problem of continuously varying the temperature. The essential components of the test chamber are shown schematically in Fig. 1. The over-all view of the test chamber in position on the platform of a standard Vickers hardness tester is presented in Fig. 2. The only modifications necessary to adapt the standard hardness tester for this application are the replacement of the conventional indenter with an extended indenter, and the removal of a calibration plug from the weigh pan of the machine to compensate for the added indenter weight. The extended indenter is commercially available and has the standard diamond 136-deg pyramid indenter.

The refrigerant, nitrogen vapor, enters the test chamber through a perforated copper coil wound around the anvil, specimen, and bottom portion of the extended indenter. The refrigerant storage and flow regulating system, similar in detail to that described by Wessel and Olleman (**4**), is shown schematically in Fig. 3. The 25-liter Dewar flask, equipped with a special transfer head (**5**), is designed so that the pressure buildup above the liquid nitrogen in the flask forces the liquid through the supply line to the perforated cooling coil.

The flow and temperature control system consists of a needle valve, a packless magnetic valve, an anticipating type temperature controller and recorder, and a copper-constantan control thermocouple. The thermocouple bead



A—Extended indenter
B—Test chamber
C—Cover plate
D—Refrigerant supply line
E—Specimen
F—Anvil
G—Perforated cooling coil

Fig. 1.—Low-temperature hardness test chamber.

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H. G. KOHUTE is research technician, Metallurgy Dept., Westinghouse Research Laboratories, Pittsburgh, Pa. His primary interest during the past few years has been the design and construction of specialized testing apparatus and the development of new testing techniques.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

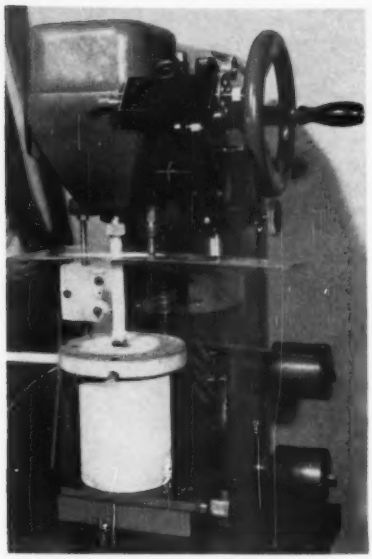


Fig. 2.—Low-temperature hardness test chamber in position on hardness machine.

is placed in a small hole on the surface of the specimen to avoid any direct contact of the bead with liquid nitrogen. The magnetic valve is opened upon demand for heat removal, and nitrogen vapor is supplied to the anvil, specimen, and indenter. The flow is regulated by the needle valve. The control characteristics and capabilities of this type of system have been adequately described (**4**). The specimen temperature over the range from room temperature down to −196 C can be controlled to within ±2 C.

The test chamber anvil is parallel to the base of the test chamber, and specimens are prepared so as to have opposite faces parallel. Thus, it is not necessary to level each specimen prior to making impressions. The chamber is mounted on a traversing stage which allows a series of impressions to be made easily. Hardness determinations for several test temperatures can be made on the same specimen by simply moving or rotating the chamber. The normal Vickers cycle is used to make the hardness impressions.

No means for reading the impression size at reduced temperature is provided. The specimens are removed from the container and allowed to warm to room temperature. The impression size is then determined using the conventional microscopic procedure. A correction may be applied to determine the impression diagonal at the test temperature using the relationship:

$$D = D_o\,[1 + \alpha\,(T - T_o)]$$

where:

α = mean coefficient of thermal expansion between T and T_o,
D_o = impression diagonal at room temperature,
D = impression diagonal at test temperature,
T = test temperature, and
T_o = room temperature.

It is easily shown that the correction for metals at temperatures down to −196 C is negligibly small, being much less than one DPH (diamond pyramid hardness) number.

Experimental Data

Hardness values for recrystallized electron-beam melted columbium in the temperature range from 20 to −196 C are shown in Fig. 4(*a*). The temperature dependence of the hardness values is almost identical to that of the various flow stress criteria (**6**) for the same lot of material shown in Fig. 4(*b*).

The correlation of various criteria of strength and the hardness values is shown in Fig. 5. This correlation is very good when made with the proportional limit in tension and compression, and with the flow stress after 3 and

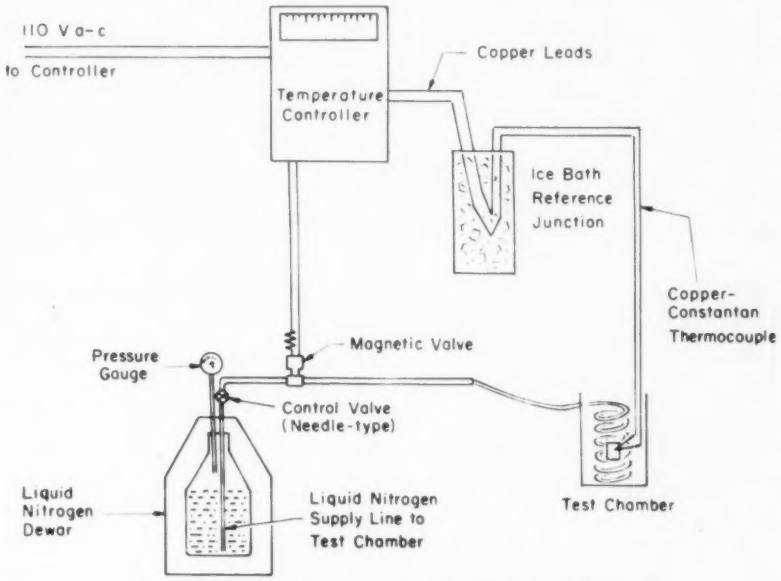


Fig. 3.—Refrigerant transfer and temperature control system.

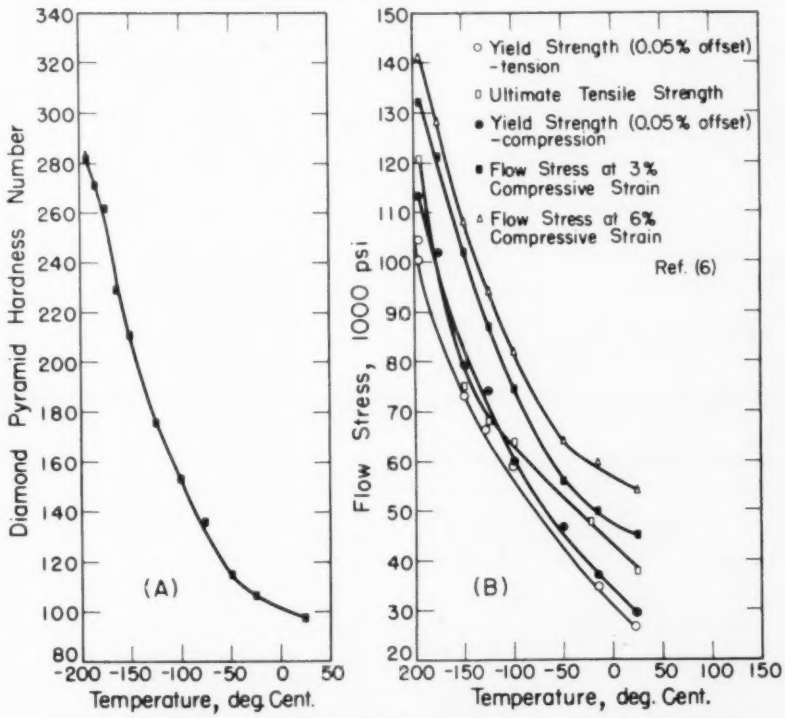


Fig. 4.—Temperature dependence of flow strength and hardness of columbium.

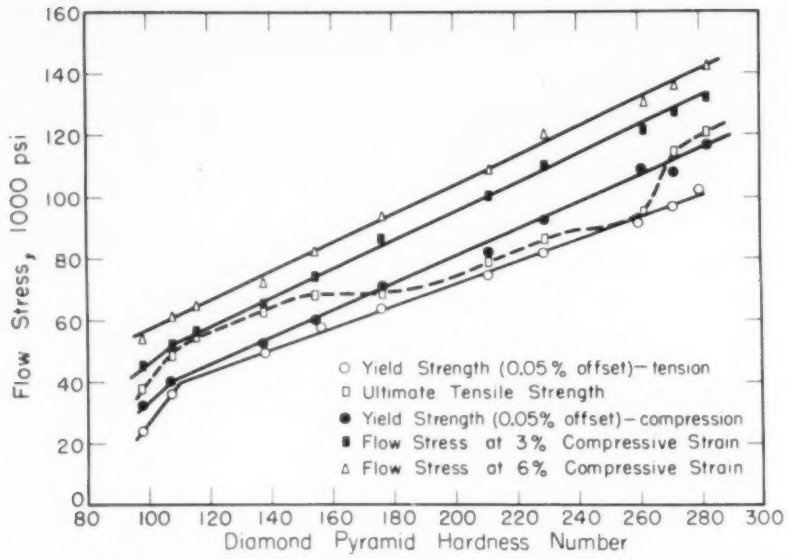

Flow Stress, 1000 psi
Diamond Pyramid Hardness Number
Yield Strength (0.05% offset)—tension
Ultimate Tensile Strength
Yield Strength (0.05% offset)—compression
Flow Stress at 3% Compressive Strain
Flow Stress at 6% Compressive Strain

Fig. 5.—Correlation of flow stress and hardness of columbium at low temperatures.

6 per cent compressive strain. Numerous investigators (**7–11**) have shown a relationship between room-temperature hardness and ultimate tensile strength, and such a correlation could be expected at low temperatures. However, the data of Fig. 5 show that correlation between low-temperature hardness and ultimate tensile strength is not as good as the correlation with flow stress at relatively small strains.

The relatively poor correlation between low-temperature hardness and ultimate strength may be a result of anomalous flow behavior at low temperatures. In tension tests, localized deformation is frequently encountered at low temperatures, resulting in very low uniform elongation values. This localized deformation is thought to be associated with local heating of the specimen, and this phenomenon could lead to questionable ultimate tensile strength values.

Conclusions

Equipment for conducting hardness tests at temperatures down to −196 C has been developed. An excellent correlation has been found to exist between low-temperature flow stress and hardness for columbium. It appears that low-temperature measurements will be useful in providing preliminary information concerning the effect of metallurgical variables on the low-temperature properties of materials. In combination with hot hardness tests, the low-temperature measurements should provide a quick and conventional method of obtaining useful information on the strength of metals and alloys over a very wide temperature range.

References

(1) R. L. McGee, J. E. Campbell, R. L. Carlson, and G. K. Manning, "The Mechanical Properties of Certain Aircraft Structural Metals at Very Low Temperatures," *WADC Technical Report 58-386*, Wright Air Development Center, Dayton, Ohio, Nov., 1958.

(2) J. Engl and J. Katz, "Temperature Dependence of the Cone Hardness of Metals," III, *Zeitschrift für Physik*, Vol. 109 (1937) p. 1.

(3) G. A. Geach, private communication.

(4) E. T. Wessel and R. D. Olleman, "Apparatus for Tensile Testing at Sub-Atmospheric Temperature," ASTM Bulletin, No. 187, Jan., 1953, pp. 56–60.

(5) A. Wexler and W. S. Corak, "A Transfer Device For Low Boiling Liquids," *Rev. Scientific Instruments*, Vol. 21, No. 7, July, 1950, p. 583.

(6) E. T. Wessel, L. L. France, and R. T. Begley, "Flow and Fracture Characteristics of Electron Beam Melted Columbium." Presented at AIME Columbium Metallurgy Symposium, Hotel Sagamore, Lake George, N. Y., June 9–10, 1960.

(7) R. E. Lenhart, "The Relation of Hardness Measurements to the Tensile and Compressive Flow Curves," *WADC Technical Report 55-114*, Wright Air Development Center, Dayton, Ohio, June, 1955.

(8) D. Tabor, "The Hardness and Strength of Metals," *Journal*, Institute of Metals, Vol. 79 (1951), p. 1.

(9) D. Tabor, "The Hardness of Metals," Clarendon Press, Oxford (1951).

(10) R. Böklen, "Über den Zusammenhang Ludwikärte-Flie β kurve mit Hilfe der Energiebilanz," *Metall*, Vol. 7, 1953, p. 436.

(11) R. Greaves and J. A. Jones, "The Ratio of the Tensile Strength of Steel to the Brinell Hardness Number," *Journal*, Iron and Steel Inst., Vol. CXIII, No. 1, 1926, p. 335.

Technical Note

A Cryostat for Mechanical Testing of Materials

By G. C. Ives[1] and J. A. Mead[1]

The apparatus which has been developed in these laboratories for low-temperature testing was originally designed to evaluate the properties of materials at temperatures in the region of −160 C, using liquid nitrogen as coolant. It owed its working principles to a paper by Wessel and Olleman,[2] who described a technique for measuring the tensile strengths of metal specimens at temperatures near that of liquid nitrogen; however, our apparatus was very much simpler in construction, and the basic components were adaptable for use with a range of testing machines. A full description of this original design appears elsewhere.[3]

This apparatus has now been modified to meet new requirements for test data in the temperature range between −100 C and room temperature. Essentially, the modification consists of improvement to the liquid nitrogen supply

[1] Yarsley Testing Laboratories Ltd., Chessington, Surrey, England.

[2] E. T. Wessel, and R. D. Olleman, "Apparatus for Tension Testing at Subatmospheric Temperatures," ASTM Bulletin, No. 187, Jan., 1953, p. 56 (TP 10).

[3] G. C. Ives and J. A. Mead, "Physical Properties of Polymers," *Monograph No. 5* Soc. Chemical Industry, London (1959).

system. The liquid nitrogen moves from its storage flask to the cold chamber of the apparatus through a dip tube which passes from the bottom of the vessel up to a well-insulated pipe of minimum length and thence to the apparatus (see Fig. 1). No valves or other restrictions are included in this line. The liquid nitrogen container is otherwise sealed, except for one vent pipe connected to the vapor above the liquefied gas, the increase in pressure of this vapor caused by continual slow evaporation of the "gas" forces liquid or cold vapor into the low-temperature working chamber.

Temperature is controlled by releasing or reducing the excess pressure in the storage flask, and to this end the vent pipe is connected directly to an adjustable pressure-relief valve, No. 1 (Fig. 1) and by way of a solenoid valve to relief valve No. 2. In operation, the settings of the valves are adjusted so that valve No. 1 permits the driving force in the flask to be high enough to ensure an adequate supply of coolant to the chamber, but the pressure is such that the supply is not excessive, and overshooting is avoided. The second pressure-relief valve is brought into action by the opening of the solenoid valve, which in turn is actuated by a temperature controller with a sensing element in the cold chamber. This second valve is adjusted to control the pressure at a value slightly below that necessary to ensure a supply of coolant to the working chamber, and thus an enhanced demand for coolant, initiated by a rise in temperature, can be met almost instantaneously.

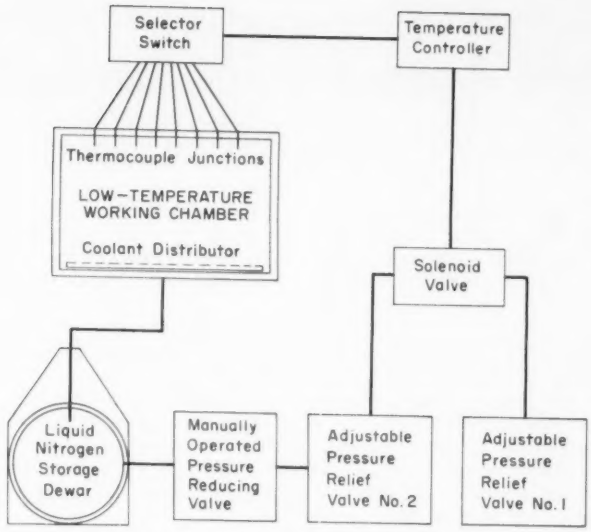
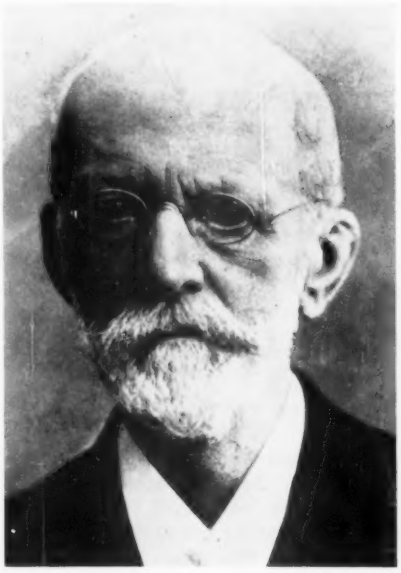


Fig. 1.—Schematic diagram of apparatus.

By the above mechanism the working chamber may be maintained at any subzero temperature above that of liquid nitrogen with ease. Temperature variations are small, and rarely exceed ±1 C from the required value. In addition, the adjustment of the two valves can be combined into one operation, and thus the continuous slow change in working pressure necessitated by the lowering of the level of the coolant in the flask may be easily compensated.



August Wöhler (1819–1914)

THE OUTSTANDING pioneer figure in the experimental study of the strength of materials under repeated stress, Wöhler entered the Prussian railway service in 1847 and was soon engaged in a study of causes of derailments and of axle failures. His famous tests were made in Berlin between the years 1852 and 1869. His machines are still preserved, and the commonest form of repeated-stress testing machines in use today, the rotating-beam machine, is practically the same as the machine designed by Wöhler.

This is one of a series of photographs from a collection compiled by Prof. Jasper O. Draffin and displayed in the Arthur N. Talbot Laboratory, University of Illinois.

Organic Adhesives for Setting Ceramic Tile

By J. V. FITZGERALD, H. B. WAGNER, and F. E. BERNETT

This is a report of an investigation of 51 organic adhesives used for setting ceramic tile. The three principal types of organic adhesives produced today were tested according to the procedures of Commercial Standard 181–52.

Shear bond strength was found to be greater than the tensile bond strength. The weakening of bond by "skinning" is reported. The stronger bond obtained in the laboratory is discussed as it pertains to the weaker bond normally obtained at job sites. Also, a procedure for testing moisture transmission through adherent sealers is explained. Some of the arguments supporting a minimum laboratory shear bond strength of 50 psi are presented.

THIS PAPER REPORTS the properties of present commercial organic adhesives used for setting ceramic tile and how these adhesives conform to the Commercial Standard, CS 181–52, "Water-Resistant Organic Adhesives for Installation of Clay Tile."[1] Additional tests are proposed which would be useful to ensure improved adhesives for bonding ceramic tile to a variety of backings under a wider range of temperature and humidity conditions.

Serious performance difficulties were encountered in the 1940's with some of the organic adhesives first used for setting ceramic tile. Consequently, many responsible persons in the industry vigorously opposed the adoption of adhesives for this purpose. Although some opposition still exists, most authorities now recognize the organic-adhesive method of setting tile as being satisfactory providing the adhesives comply with CS 181–52.

One of the groups gravely concerned about the damage to the good reputation of the tile for permanence that could result from the use of poor adhesives in place of the conventional portland-cement mortars was the Tile Council of America, Inc. The Council therefore sponsored an investigation by H. Z. Schofield and C. R. Austin at the Battelle Memorial Inst. to determine the qualities needed in organic adhesives for setting tile. The results of this investigation[2] were published in 1949 and served as the basis for CS 181–52.

Commercial Standard 181–52 adopted most of the recommendations except that laboratory shear bond strength requirements were reduced by compromise from 100 psi to 40 psi. Nonetheless, the standard, and also Schofield and Austin's recommendations, have been a constructive influence encouraging the maintenance of reasonable quality in tile setting adhesives during this period. Consequently, many adhesives now carry the hallmark declaring compliance with all the requirements of that standard.

In the decade since the report by Schofield and Austin the use of organic adhesives has increased—a major objective of this study was to see how well their adhesives have conformed to CS 181 in the light of their acceptance by the construction industry.

Fifty-one different proprietary organic adhesives, claimed to be suitable for setting ceramic tile, were tested according to the procedures of CS 181–52. Results of the tests are shown in Table I and may be easily analyzed to show how present quality is being maintained.

The shear test assemblies of CS 181–52 consist of overlapping $4\frac{1}{4}$ by $4\frac{1}{4}$-in. glazed wall tile adhered back-to-back with a $\frac{1}{4}$-in. overhang, the thickness of the adhesive layer being $\frac{1}{16}$ in. The bonded area is thus $4\frac{1}{4}$ by $3\frac{3}{4}$ in., or approximately 16 sq in. After conditioning at the prescribed temperature, moisture, and duration shown in Table I, compres-

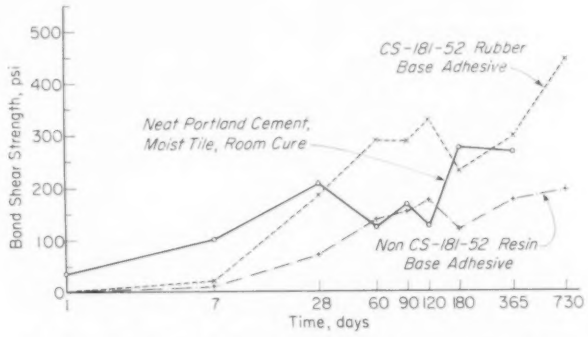


Fig. 1.—Time versus shear strength of tile setting materials.

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NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author or authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] U. S. Department of Commerce, Washington, D. C. Sponsored by the Tile Council of America, Inc.

[2] H. Z. Schofield and C. R. Austin, "Properties of Organic Mastics for Installing Ceramic Wall Tile," *Bulletin*, Am. Ceramic Soc., Vol. 28, pp. 50–56 (1949).

sion loading of the projecting ends of the assemblies is applied at the rate of $\frac{1}{8}$ in. per min. The shear bond strength is the force per unit area expressed in pounds per square inch, determined when the assembly fails under compression loading. Data for the different adhesives so measured are reported in Table I. Data for typical adhesives were also recorded over a much longer period of time and are graphically presented in Fig. 1.

Types of Organic Adhesives

The three basic types of organic adhesives used for setting ceramic tile are: rubber-base, resin-base, and latex-base; the commercial standard covers all three types.

Rubber-Base or Elastomeric Adhesives.—These consist of natural or reclaimed rubber emulsified and either swollen or fractionally dissolved in volatile solvents.[3] In addition, they may contain inorganic fillers such as talc, carbon, or wollastonite, and pigments such as titanium dioxide, plasticizers, and antioxidants.

Resin-Base Adhesive.—This type of adhesive usually contains plasticizers, fillers, and solvents—the resin being the main functional component. According to ASTM Definitions D 883[4] a resin is "a solid, semi-solid, or pseudo-solid organic material which has an indefinite and often high molecular weight, exhibits the tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally." Generally, the resinous material tends to be dissolved to a greater extent in the solvent constituents than the rubber in the rubber-type adhesive. At least one resin-base product is now sold in the form of a powder which, when mixed with water, becomes a water-resistant adhesive suitable for setting tile.

Polymeric Emulsions or Latices are also commercially available. These consist of water-dispersed rubber or polymers containing minor proportions of stabilizing additives.

Solvent Content of Resin-Base and Rubber-Base Adhesives

No benzene or halogenated solvents were detected in any of the 13 tile adhesives analyzed. The fact that only aliphatic hydrocarbons, alcohol, and water comprised the volatile portion of these products indicates that inhalation toxicity and fire hazard should not be encountered with these materials under ordinary conditions and temperatures and with reasonable ventilation.

The loss of volume that occurs when the solvent evaporates from the adhesive is responsible for a dimensional change or shrinkage, which, if large, can crack the rigid portland-cement grouting materials commonly used to fill the joints between tile. Consequently, modern tile installation specifications recommend that after setting the tile grouting operation be delayed until solvent vapors have evaporated.

Shear Versus Tensile Strength

Ceramic tile adhesives must resist both shear and tensile stresses. Laboratory assemblies consisting of glazed wall tile installed with resin-base adhesive No. 30, back-to-back, failed completely in tension at only $\frac{1}{8}$ the force that caused failure in shear. A typical rubber-base adhesive reacted differently when tested in the same manner, in that its tensile strength was relatively greater:

TABLE I.—SHEAR BOND STRENGTHS OF COMMERCIAL ORGANIC ADHESIVES USED IN SETTING CERAMIC TILE AND TESTED ACCORDING TO COMMERCIAL STANDARD 181-52, PSI.

Specimen	Specimen Dried to Constant Weight				Specimen Tested After Intervals of Time				Type of Adhesive
	73.5 F	125 F	−20 F	7 days wet	16 hr	7 days	28 days	7 days wet	
No. 1	1	3	47	1	0	1	15	0	Resin
No. 2	3.3	6.4	...	0.4	0.3	1.0	12	0.3	Rubber
No. 3	6	2	2	0	5	21	16	0	Resin
No. 4	8	1	61	0.3	1	4	27	0	...
No. 5	8	7	44	8	0.2	7	17	1	...
No. 6	13	10	5	2	1	26	50	3	...
No. 7	13	15	91	10	1	3	18	2	Resin
No. 8[a]	21	2	195	4	2	4	24	0	Rubber
No. 9[a]	25	3	148	24	0	0	13	0	Rubber
No. 10[a]	26	3	250	0	1	8	34	0	Rubber
No. 11	30	0	203	15	0	22	103	6	Rubber
No. 12	33	23	86	2	1	4	42	0	Resin
No. 13	38	12	...	12	1.3	18.9	50	0.6	Latex
No. 14	41	29	281	0	1	28	99	1	...
No. 15	44	20	104	0.8	2	34	84	0	Resin
No. 16	48	13	88	0	6	19	31	0	Resin
No. 17[a]	55	4	382	61	2	37	105	44	Rubber
No. 18[a]	63	17	372	62	2	39	51	53	Rubber
No. 19	63	18	22	8	2	11	64	0	Resin
No. 20	66	12	48	4	1	20	92	0	Resin
No. 21[a]	72	8	450	4	0	8	58	0	...
No. 22	73	70	33	19	2	38	75	0	Resin
No. 23	74	10	450	94	1	33	79	36	Rubber
No. 24	76	15	...	3.6	4.0	26	89	0.4	Resin
No. 25[a]	86	18	450	109	1	68	115	82	Rubber
No. 26	91	40	230	80	15	85	124	87	Rubber
No. 27[a]	94	16	447	94	6	62	94	83	Rubber
No. 28[a]	118	62	450	27	1	62	107	19	Rubber
No. 29[a]	127	29	222	52	4	71	101	23	Rubber
No. 30[a]	128	25	450	44	1	45	148	6	Resin
No. 31[a]	134	56	142	32	7	106	100	30	...
No. 32[a]	144	27	423	81	0.4	38	168	21	Rubber
No. 33[a]	145	19	450	63	0	3	91	7	Rubber
No. 34[a]	147	49	412	78	0.5	43	172	19	Rubber
No. 35[a]	157	5	...	26	3	2.5	54	0.5	Latex
No. 36[a]	160	41	439	103	3	80	169	69	Rubber
No. 37[a]	163	70	...	70	0.9	31	223	10	Rubber
No. 38[a]	167	76	450	140	15	110	147	81	Rubber
No. 39[a]	170	31	283	67	2	63	211	68	Rubber
No. 40[a]	181	36	178	70	2	94	172	102	...
No. 41	182	68	356	0.5	11	70	196	0	Latex
No. 42[a]	184	93	450	164	12	107	248	127	Rubber
No. 43[a]	194	29	178	83	9	112	146	49	Rubber
No. 44[a]	198	60	440	78	6	145	167	44	Rubber
No. 45[a]	200	72	450	143	7	103	217	102	Rubber
No. 46[a]	214	...	...	47	20.3	19	94	0.5	Resin
No. 47[a]	216	46	460	44	1	12	159	1	Latex
No. 48[a]	216	61	220	38	6	109	174	27	Rubber
No. 49[a]	244	213	...	77	20	142	295	73	Resin
No. 50	269	54	210	91	0	38	125	1	Rubber
No. 51	450	440	450	172	32	208	438	137	Latex
CS 181 Limits, psi	40	30	40	40	0.5	10	40	10	

[a] Commercial Standard 181-52 hallmark on label.

TABLE II.—CHANGE IN SHEAR STRENGTH DUE TO SKINNING OF ADHESIVE ON CERAMIC TILE PRIOR TO INSTALLATION, PSI.

Open Time, min	No. 22, Resin Base	No. 15, Resin Base	No. 32, Rubber Base	No. 18, Rubber Base	No. 41, Polymer Emulsion
0	32.2	37.5	87.0	50.6	88.5
5	96.9	15.0	84.4	36.2	41.2
15	95.4	25.0	76.3	55.9	57.2
30	53.7	35.6	82.6	57.2	29.4
60	53.1	32.5	77.2	35.6	7.2
120	29.1	19.4	66.6	40.9	0.9

[3] The properties of rubber-base adhesives can also be tested by Methods of Testing Rubber Cements (D 816-55), 1958 Book of ASTM Standards, Part 6, p. 670; Part 9, p. 1743.

[4] Definitions of Terms Relating to Plastics, 1959 Supplement to ASTM Book of Standards, Part 9, p. 139.

Adhesive	Shear Strength	Tensile Strength
Resin-base.....	65 psi	12 psi
Rubber-base....	195 psi	76 psi

Although the rubber-type adhesive showed considerable displacement of the tiles in shear, it did not produce complete loss of bond.

Certain adherents tested cannot take advantage of the high strength of organic adhesives. For example, an aluminum-foil-faced gypsum wallboard failed in shear at 52 psi and in tension at 17 psi; the gypsum beneath the paper failed in each case.

Skinning Effect on Bond of Adhesives to Ceramic Tile

Effect of skinning on representative resin-base, polymer-emulsion, and rubber-base adhesives, Table II, was determined using the method described by Schofield and Austin.[2] Before bonding, a second tile was exposed to air at room temperature for the times indicated in Table II. After bonding, a drying period of nine days was allowed before testing in shear.

Setting of Tile on the Job Versus Laboratory Tests

Laboratory tests idealize actual job conditions in that there is 100 per cent coverage by the adhesive. Aside from the human element, the trowels commonly used reduce the coverage and thereby reduce the average shear bond strength obtainable.

A study was conducted to evaluate the per cent coverage on backs of wall tile of adhesive No. 25 applied with notched trowels. The two variables investigated were the type of trowel and the style of the back pattern of the tile.

First, the per cent coverage was measured, and, second, the tensile bond strength was measured in an effort to correlate the expected per cent coverage with a minimum bond strength. Three different variations of back patterns and six different styles of notched trowels were included.

As would normally be expected, the results indicated that the trowel which put down the greater average thickness of adhesive gave greater coverage to the applied tile. A sawtooth trowel was found to be most effective, since the adhesive did not have to squeeze laterally to make full contact with the backing. This trowel equalized the effect of back pattern variation.

The most important fact noted, however, was that an adhesive coverage of around 40 per cent will give a tile bond potential of at least 45 psi in tension with a moderate-strength adhesive. Forty per cent is believed to be a safe lower limit for specifying adhesive coverage.

Setting of Tile Accessories by Adhesives

Tile accessories are such items as soap dishes, tumbler holders, grab rails, etc., pressed or cast from ceramic materials and having a glazed surface finish. Two basic types of accessories are those that project outward from the tile face and those that recess into the wall (certain types that project outward are called semi-recessed). Some manufacturers produce accessories designed for adhesive and mortar setting, and certain types for adhesive setting only.

Test studies using these accessories showed that adhesives conforming to CS 181–52 ensure safe handholds.

Sealers for Surfaces to Receive Ceramic Tile Set by Adhesives

The setting of ceramic tile by organic adhesives in wet areas around tubs and showers is made more critical than the setting on walls not exposed to moisture. Therefore, the adhesive must be water resistant. Nevertheless, when water-susceptible backing materials such as unprotected gypsum wallboard, plaster, or plywood are used, it is also important to protect the backing material itself by a sealer to avoid failure because of water damage of the backing. Many authorities believe that even when sealed, gypsum plaster, gypsum wallboard, and also plywood may still be damaged in wet areas and therefore they strongly recommend against such applications.

A second reason for sealing is that an absorbent backing material may extract essential constituents such as plasticizers and oils from some adhesives and thereby cause them to become brittle or to lose their strength. The sealer therefore acts as a barrier between the adhesive and the adherent.

Adhesive manufacturers have approved sealers which include troweled-on adhesives, adhesives cut with solvent and spread with a fiber brush, and especially prepared commercial sealers. Nearly every adhesive manufacturer has specific recommendations regarding priming.

Satisfactory sealers for surfaces to receive ceramic tile set by adhesives include: acrylic emulsions, cholorinated rubber, reclaimed rubber, some natural resins dispersed in alcohol, petroleum asphalts dissolved in hydrocarbons, and marine varnishes.

At least three characteristics of a sealer must be determined in order to evaluate properly its usefulness in the installation of ceramic tile: the ability to waterproof, compatability with the tile adhesive, and the effect on the strength of the adhesive bond.

In this study 15 sealers were tested; of these only 7 were found to be good waterproofers.

Slippage of the tile over sealed surfaces and bond strength were observed after 24 hr. The tests demonstrated that reactions between sealers and adhesives cause large slippage in some cases. Use of different adhesives over the same sealer often gave greatly different amounts of slippage. Consequently, a sealer and adhesive always should be tested for compatibility.

Fig. 2.—Checking backing paper with Goodrich moisture meter to determine waterproofing effectiveness of adhesives and sealers.

The procedure for testing sealer and adhesive waterproofing developed by H. R. Goodrich. (Fig. 2), requires grinding of the glaze from a $\frac{3}{4}$-in. diameter area of a tile, then mounting it with adhesive on 6 by 6 by $\frac{3}{8}$-in. gypsum wallboard treated with the sealer being tested. After the adhesive has set, a glass cylinder 2 in. inside diameter by $2\frac{1}{4}$ in. is cemented around the removed glaze. After one week the assembly is placed on uncoated kraft paper on the glaze of a 6- by 6-in. tile. Moisture is determined by means of a Weston Midget Moisture Meter (Model 8009) at the bottom of the wallboard before addition of 100 ml of water to the cylinder and again each 24 hr for the first several days and then at weekly intervals. The water level in the jar is brought up to the 100-ml mark each day. If a moisture meter is not available, kraft paper will act as a moisture indicator by wrinkling, which becomes progressively more pronounced as the moisture content increases.

Moisture readings obtained by this test have shown that some rubber-base adhesives are quite effective as moisture barriers even without priming. However, resin-base adhesives always transmitted excessive water.

Minimum Bond-Strength Requirement for Adhesives Used in Setting Ceramic Tile

Schofield and Austin simulated field conditions in accelerated laboratory tests in which they determined the loss of strength in organic adhesives exposed to (1) dampness, (2) wetting

cycles, (3) extremes of temperatures, (4) temperature fluctuations, (5) aging and oxidation, and (6) skinning-over during application. In addition to these environmental factors, they discussed the fact that some adhesives were not suitable for tile setting because they had virtually no resistance to (7) mechanical shock, (8) resistance to mold growth, and (9) attack by vermin.

TABLE III.—SHEAR BOND STRENGTH STANDARDS, PSI.

	Schofield and Austin	CS 181–52
75 F	100	40
−20 F	100	40
125 F	35	30
10 cycles 75 to 125 F	100	None
10 cycles 75 to −20 F	100	None
Aging 16 hr	1.5	0.5
Aging 7 days	25	10
Aging 28 days	100	40
Soaking 24 hr	100	40
Soaking 7 days	...	10
Soaking 10 cycles	[a]	None
Oxygen 144 hr	100	None
Skinning 30 min	70	None

[a] 70 per cent dry strength.

Based on the results of their investigations, Schofield and Austin recommended a series of specific bond-strength specifications which would guarantee a high-quality standard for organic adhesives for installing ceramic wall and floor tile. The recommendations are shown in Table III with the requirements of CS 181–52, which are considerably less severe.

Safety factors, for bond strength should account for the stresses caused by thermal and structural movement of the adherent, failure to apply the adhesive perfectly, lack of ideal conditions at job sites, and also possible or probable bond deterioration with time or oxidation, as well as weakening by humidity and temperature.

The safety factor is in the excess bond strength over what is required to support the weight of the tile. For many years the tile industry has recognized 50 psi as the minimum shear-bond strength for tile to give satisfactory service under normal conditions where hydraulic cements are used. Federal Specification SS-T-308 also requires test results of at least 50 psi. In tunnels and similar areas subjected to vibration, it has been found that tile installations give good performance where laboratory bond strengths are specified to be at least 100 psi—as is required by the New York City Port Authority. The present trend is to insist on substantially greater bond strengths. For example, American Standard Specification for Dry-Set Portland Cement Mortar, A118–1, 1959, requires the shear strength of mortar to glazed wall tile to be at least 250 psi after 12 weeks.

[5] R. Pangels, "Investigation of Bonding of Wall Tile to Mortar," The Wall Tile Firm, Villeroy and Boch, Danischburg, 1937.

To be effective, laboratory standards must be correlated with field experience. In one set of experiments, the Tile Council of America staff engineers established that glazed wall tile bonded directly to a 1: $\frac{1}{2}$:4 cement-lime-sand mortar had an average bond strength of 25 psi. When a neat cement paste layer $\frac{1}{32}$ to $\frac{1}{16}$ in. thick was used between the tile and mortar, the shear strength at rupture was 200 psi. In one section of the United States, many tiles were set directly on the mortar without recourse to the neat cement. Too many failures were reported in which tile came loose because they could not resist the normal shrinkage stresses of the backing, which in this case was an early type of concrete masonry. On the other hand, where neat cement paste was used the type of failure of bond between wall tile and mortar was practically unknown. These laboratory and field investigations form the basis of a Tile Council requirement that all specifications require that neat cement paste shall bond tile to regular portland-cement mortars.

R. Pangels[5] described a correlation of laboratory bond-strength measurements with field experience in his report of an extensive investigation of tile problems in Germany. In this case, laboratory tensile strength of tile bonded for five months to mortars was determined instead of the shear strength. Where tensile bond strengths of 23 to 40 psi were obtained on laboratory specimens, little trouble was encountered in the field with tile which had been similarly set and presumably attained this approximate bond strength. However, laboratory tensile strengths of only 8 to 17 psi were observed for tile set by a technique which was characterized by excessive loose tile problems in the field.

A large fraction of tile installed by adhesives is on gypsum wallboard. In one series of tests it was noted that the wallboard had a paper-to-core shear strength in the surface plane of 56 psi for "A" brand tested and 72 psi for "B" brand. Therefore a ceramic tile adhesive with less than 50 to 70 psi shear bond strength would be the weakest link in a dry gypsum wallboard installation, unless, of course, the gypsum itself would fail at a lower shear value, as was the case for the foil-faced board mentioned earlier.

Conclusions and Recommendations

Too many organic adhesives now being sold to the tile trade are misrepresented by carrying the hallmark claiming conformance with CS 181–52 when in fact they do not. More careful testing by the manufacturers is needed to minimize such misrepresentation.

Since the performance requirements for ceramic tile installations generally include resistance to water—hot and cold, as in showers—the adhesives used should likewise be relatively unaffected. While the requirements of CS 181–52 are very modest regarding water resistance, many adhesives, nevertheless, do not comply, some even failing immediately when wetted.

Although organic tile-setting adhesives are of three broad types, the composition was found to be a non-critical factor in compliance with CS 181–52.

A test for evaluating the durability of organic adhesives in moist alkaline environments is needed. Some problems have occurred when condensation at the interface between the adhesive and concrete backings dissolved alkaline salts and saponified the adhesive. A standard for sealants to be used over backings where tile is set by adhesives is also needed. Some backings are so water-susceptible that very careful waterproofing is required before they will be generally acceptable in wet areas. Other backings absorb solvents and tend to extract the plasticizers, embrittling the adhesives, and therefore should have a protective sealant or primer. For many adhesives, concrete backings should be either treated by a neutralizing agent or protected by some kind of coating.

Ceramic tile is being used more and more on exteriors. Adhesives suitable for such applications must have additional qualities not presently covered in CS 181–52. For example, they must not be adversely affected by freezing-and-thawing cycles, very low humidity, relatively high temperatures or total immersion in water. For better performance of ceramic tile subjected to concentrated load on floors, adhesives should become more rigid without loss of bond. A test for such a property would be useful. Flexibility without loss of bond but after long-time aging is important as modern construction "moves" a lot more than older construction. Here again a simple testing procedure is needed. In fact, a more satisfactory accelerated aging test should be developed as soon as possible.

In the light of its investigations, the Tile Council of America urges that 50 psi be considered the minimum safe shear bond strength for installation of ceramic tile using organic adhesives.

Acknowledgment:

Credits for laboratory investigation of the adhesives described in this report are due R. J. Kleinhans and Joseph Spataro. Also, this will acknowledge review and authorization to publish by the Research Committee of the Tile Council of America, Inc.

COMMENT

What Price Green Cheese?

THE PRESIDENT'S Science Advisory Committee has recently estimated the cost to us of landing a man on the moon. Its members were shocked to find that, over the next ten years, this may reach the staggering total of $40 billion. And this may be quite conservative—the cost of Project Mercury is now running about double the original estimates.

This out-of-this-world price tag, coupled with the many other research projects clamoring for attention, has prompted the committee to back off and take a look to see whether the Federal Government may not be preparing to spend too much money for research in the wrong places.

Certainly, few will question the rightness of massive government support of science. In the words of the recent report of the committee's Panel on Basic Research and Graduate Education, "We think it plain that the Federal Government should act in such areas of scientific promise. No other agency in our society is responsible for the national security, and a large field full of new problems, such as space science or materials research, is potentially vital to our safety. No other agency has the financial strength to provide the necessary support—and incentive—for work in expensive new undertakings. It can be said without qualification that our society will be endangered and impoverished if these things are not done, and that only the Federal Government can take the leadership to get them done . . ."

Certainly, too, few would question the long-range value of space research. Although the hardware to accomplish it is fantastically expensive, and its development is in the area of engineering and not of basic research, the information that it gathers for us is of the most basic sort, that is, it deals with questions about our universe whose answers serve only to assuage our curiosity, and have no immediate application to gadgetry. But who can estimate the long-range benefits to mankind of such information? The idle questions of the scientists must be answered. The fruits of basic research are like money in the bank—there to draw upon when needed. When the account is exhausted, progress ceases.

The question, rather, is one of priorities. And the question is terribly complicated by matters of defense, politics, propaganda, power, prestige, and common humanity.

Can we justify billions for man-in-space while untold numbers of Nature's secrets remain locked in our own great oceans? Should a nation with 685,000 pupils attending school part-time because of a shortage of 142,000 classrooms devote such a large proportion of its limited resources to one area of endeavor? What about inadequately prepared teachers? What about the tens of thousands of our mentally ill who are getting only "custodial" care? The 1960 annual report of the American Heart Association says that "double the sums now available could be used effectively to speed conquest of heart disease." In short, how does one allocate priorities in the Cold War *vis à vis* the war on poverty, ignorance, disease, hunger, filth, illiteracy?

It is good that the post-Sputnik fever has abated sufficiently for the Science Advisory Committee to ask such questions. Its responsibility is awesome. One can but wish it well.

A.Q.M.

The Role of Technical Societies*

By C. H. LORIG[1]

THE ROLE OF technical societies in today's industrial world is fivefold: (1) to mobilize unorganized knowledge, technologies, and services; (2) to bring together people with common interests and offer them a multitude of related services; (3) to provide a forum where a man can present his ideas, works, and conclusions to the critical appraisal of his peers; (4) to develop effective channels of communication for technical knowledge; and (5) to provide an environment through meetings, seminars, and publications for logical interpretation and suggested applications of scientific and technical facts.

We have no other agency that can fulfill all these vital functions. Nothing that we have can approach the technical societies in supplying those technological resources and stimuli that are so necessary to our national growth. The simple fact that scientists and engineers with essentially common interests can come together at technical meetings to discuss their work and exchange ideas tends to provide an intimate working relationship between the scientist who seeks general laws of nature and the engineer who must give them economic application.

Must Be Alert to Change

To play its role properly, however, a technical society must remain alert to a changing technology, which in these days can be rapid. Unless a society keeps alert and designs its program to be capable of fulfilling everchanging needs, it can quickly pass from the picture. Remaining static for a period as short as five years can do irreparable damage to an organization. Operations in narrow fields are at the mercy of a change in the importance of a single technology. I cite the complete and rapid conversion of steam locomotion on our railroads to diesel power and the present trend to atomic-power-driven submarines and ships. Moreover, the technology of space will have the most profound impact upon our affairs one of these days. Leaders of a technical society must, therefore, remain aware that a new scientific discovery may suddenly lessen—or even eliminate—the need for the society.

A society must also have the intelligence, the ingenuity, the know-how, and the determination on the part of its leaders to develop the latent resources of the organization into actual, usable wealth. Many new societies are short-lived through inability to finance the organization that is essential to their existence. From a practical standpoint, the services rendered by a society do have certain limitations. Meetings, publications, educational programs, and serving the specialized interests of members are costly operations. Just how far a society can go to provide all these facilities is linked to its income. Yet, in spite of practical limitations growing out of the cost of such services, technical societies are performing a function that is indispensable to all who are in research or who must plan and administer the research programs that are so vital to their success.

The diversity in some societies is impressive, and we should expect even greater diversity as technology becomes increasingly more specialized and complex. Societies are being forced by change to widen their scopes; the range of scientific and technical knowledge has extended so greatly within a generation that it is a constant challenge to keep abreast of the trends. The need for a continued fresh approach to the problem is urgent. Methods must be found for adjusting the structure of societies to take account of the specialized and newly acquired interests of their members.

Primary Task Is Education

It should be obvious to all that the primary task of technical societies has been and will continue to be the promotion of education. Their central mission is to advance and disseminate scientific and technical knowledge. No one these days can know all about any one thing. Technical societies today offer us an opportunity to tap almost as rapidly as they are generated the best sources for new scientific and technical information that we need in our research planning. There are no other agencies open to such world-wide sources where technical information can be gathered as promptly and completely as through such society functions as meetings, seminars, conferences, technical discussions, and current technical publications. Personal contacts made at society meetings, which bring together people with diverse experiences and varied kinds of information, are added benefits.

The Information Problem

Although the technical societies do provide the vast sources of new information which constitute an Open Sesame for new ideas, there are so many individuals developing the information, so many collecting data, and so many engaged in research studies that the problem of rapid and adequate dissemination is exceedingly complex. Many of the details of a piece of work cannot be described adequately in a written report. Some of this information is being exchanged on an interpersonal basis among those engaged in research and development. Unfortunately, the bulk of this unpublished information is being lost. Of the information being published, there can be great time lags between its generation and its publication. Because of this lag, users of the information are frequently at a handicap. What we need, of course, is to find ways to improve the flow of information from the point of origin to the point of use. This logically fits into the work of our scientific and technical societies and should become one of their major responsibilities.

In the last two decades the growth of research has been astounding. In terms of dollars spent it has increased nearly 30-fold. Within the next decade it is expected that the amount of human energy that will go into research and development will exceed all the energy expended on research, development, science, and pilot-plant technology since this nation was formed. Research management is burdened with the problem of seeing that results are used effectively and that the fruits of research do not lie idle to rot unused.

Technical societies must acknowledge the value of shortening the delay between discovery and application of knowledge and thus do what they can to help disseminate technical information more quickly and widely. They are being forced by vast accumulations of new knowledge to develop better lines of communication with their member-

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* Based on a paper presented at the Seminar on Research Planning and Management, sponsored by the Office of Naval Research, Aug. 26, 1960, at Princeton University, Princeton, N. J.

[1] Technical Director, Battelle Memorial Inst., Columbus, Ohio.

ship. This has some vexing problems, to be sure. But in the long run this new alignment of services has the advantage of requiring the societies to remain alert, to be frugal and industrious, and to increase their efficiency.

In the past, as many as 10 years or more elapsed between the first discovery of a new or improved material in the laboratory and its ultimate, wide-scale use in production. Today this lead time is from 7 to 8 years in the United States but only 5 years in Russia. Demands of our defense, atomic energy, and space programs bring this problem of lead time to the forefront by the need to make haste. Developments in each of these areas must now be rushed through stages that formerly would have required years. Demands within these areas have increased more rapidly than we have been able to streamline our programs to use more effectively the information already on hand.

There seems to be no question but that speeding up the collection and dissemination of scientific and technical information could best be done by expanding and accelerating the work of technical and scientific societies already in existence. At least they should be given the opportunity. The approach they use may be largely empirical; the important thing is to identify the need and devise a way that they can meet it.

In establishing the approach it must be remembered that the needs for technical information of the research scientist as compared with the needs of the engineer are normally not the same. The research scientist often will willingly read and conduct exhaustive literature searches to gather information on all facets of his problem. The engineer, on the other hand, is less well equipped, is differently oriented, and the demands on his time are so varied that the information should be assembled, evaluated, collected, and put into a usable package before it is placed in his hands.

The research scientist has more time to scan all the bibliographic references an information searching service may unearth and to pluck from past examples what is useful to him today. The engineer must work to meet a deadline fixed by circumstances that are often outside his control. His interests are not so much in having access to all the information that has accumulated on any given subject, but in having access to a sound and sufficient body of useful technological information compiled in a form that he can use. Unless the information is readily at hand and in a form that requires little additional searching, he normally will pass it by because of lack of time to search.

[2] "More Effective Organization and Administration of Materials Research and Development for National Security," National Academy of Sciences–National Research Council, *Publication 718*, 1960.

More Screening, Evaluation Needed

I have a feeling that technical societies are now beginning to appreciate that screening and technical evaluation of data is just as important a function, from an engineer's point of view, as the functions of searching, storing, and retrieving of bibliographic references. Technical evaluation is normally not attempted, and, except for a few isolated instances, it has yet to be developed to the point where it can be offered to people in the engineering profession. I think we can look forward to the time when such a service will be obtained through our technical societies, or, if not through them, then, perhaps through a government agency.

Our technical societies must not only work out methods to gather information as it is released but also to make available technically adequate summaries of work that has already been done and published. In this regard, to be fully effective, technical societies might ultimately offer a clearing-house service that covers what has been done, what is being done, and what is planned to be done. This scheme may seem farfetched and outside the bounds of the present American system of free enterprise. Yet, when fortified with such knowledge, the research planner is in the best possible position to develop timely and fruitful programs free from the overlapping objectives and goals of other programs.

With the vast amount of paper already in circulation, it is imperative that technical societies through their publication policies place the bulk of their emphasis on reporting really new information, and doing that concisely. Material that is intended for publication in their journals and transactions, which constitute the bulk of the permanent body of technical literature today, should, therefore, be screened to ensure that only work of real value is preserved.

The report of the Committee on Scope and Conduct of Materials Research, released in 1960,[2] made several strong recommendations which bear on this subject.

One recommendation was that industry should support technical societies—not just financially but also by encouraging real participation by technical people in the work of the societies—and the technical societies should take on, where possible, an increased screening function for reports in their respective areas of competence.

A second recommendation was that there should be greater dissemination of foreign translations, abstracts, and original papers relating to research and technology gathered from any source. This should be done preferably through the technical journals.

Specialists Must Communicate

The committee contended that what is now needed is an extension of present programs to encourage greater cross-fertilization of narrow scientific disciplines and other measures to bring together specialists from the engineering fields with those working in the "purer" sciences of physics, chemistry, and mathematics. Those trained in the "purer" sciences must recognize the great need for applied research.

Applied research and development are the links between basic or "pure" research and our economy. Such scientific activities constitute the means for converting basic science to a useful end product. Applied research has the additional purpose of developing new scientific information, when necessary for solving its problems. There must be good communication in both directions between applied science and basic research, since results in one of these fields can strongly influence progress in the other.

Any mechanism a technical society can envision that will enable physicists, chemists, mathematicians, engineers, and others interested in technology, both basic and applied, to exchange ideas and to work together, merits support. All of us are aware there is nothing new in recognizing the interdependence of the sciences and the various branches of technology. For that reason, close liaison and cooperation between the scientific and the technical communities concerned in today's problems must continue and should be strengthened.

Existing Societies Can Do the Job

Finally, we must not allow the continuing process of specialization to fragment the energies of our technical societies. Services offered by existing societies ought to be sufficiently broad and inclusive. There is no need for "splinter" groups that are being formed today almost literally by a fission process. The larger societies should find it possible to adapt themselves to cater to specialized and changing interests. Once the large societies become sufficiently adaptable, the comparatively weak, highly selective splinter societies would be needless. To understand and accept these changing responsibilities, the larger societies must constantly reevaluate the services they offer, keeping in mind that they must remain at least abreast, and preferably ahead, of the tide of technological change. Instead of a great number of societies struggling to keep alive, we should have a strongly coordinated group made up of large and well-established technical societies that are capable of performing the normal as well as the specialized tasks they are called upon to do.

Society Affairs

ASTM Board of Directors Meeting of January 17, 1961

FOLLOWING ARE some of the actions taken at the Board meeting at Headquarters in January.

AMENDMENT OF BYLAWS

Article VIII, Section 5 of the Society Bylaws now reads as follows: "Any person elected [to membership] after six months of any fiscal year shall have expired may pay only one half of the amount of dues for that fiscal year; *but in that case he shall not be entitled to a copy of the Proceedings for the current year.*"

The Board voted to delete the words in italics. This amendment is subject to action by the membership at the forthcoming Annual Meeting and subsequent letter ballot.

NATIONAL MEETINGS

The following dates and places were selected for future meetings:

1965 Pacific Area National Meeting—Seattle, Wash., Oct. 31–Nov. 5.

1966 Committee Week—Washington, D. C., Jan. 30–Feb. 4.

1967 Annual Meeting—Boston, Mass, June 25–30.

1968 Annual Meeting—San Francisco, Calif., June 16–21.

GROUP INSURANCE FOR MEMBERS

The charter enrollment period for the Society's new group insurance program for members closed on Dec. 1, 1960. The insurance administrators believe that the number enrolled to that date will ensure a sound program. A proposal that the Society add a high-limit accidental death and dismemberment insurance plan to the program was approved by the Board.

TECHNICAL COMMITTEE ACTIVITIES

The Board approved:

Change in title of Committee D-10 from "Shipping Containers" to "Packaging," subject to a clarification of the scopes of Committees D-10 and F-2 on Flexible Barrier Materials.

Change in title of the Special Committee on Fracture Testing of High-Strength Sheet Materials to ". . .High-Strength Metallic Materials."

Expansion of the activities of Committee D-7 on Wood to include establishing working stresses on nonstructural grades of lumber with the understanding that the information developed will be considered as a recommended practice rather than a standard.

Steps to revitalize Committee E-8 on Nomenclature and Definitions and study of other steps to achieve better coordination of definitions of terms within the Society.

A Staff study on the question of establishing an advisory committee on deterioration of materials through environmental effects.

ENGINEERS JOINT COUNCIL

The Board authorized the Executive Secretary to apply for affiliate membership in the Engineers Joint Council. (This application was approved by the EJC Board on January 19.)

64th Annual Meeting
Atlantic City, N. J., June 25—30

THE 64TH ANNUAL MEETING of the Society will be held in Atlantic City, N. J., at the Chalfonte-Haddon Hall the week of June 25 to 30. Complete details of the meeting will appear with the Provisional Program in the April issue of *MR&S*.

Lectures

The 1961 Marburg Lecture will be presented by Bruce Chalmers, Harvard University. The subject of Dr. Chalmers' lecture will be crystal nucleation. A. B. Kinzel, vice-president for research, Union Carbide Corp., will deliver the Gillett Memorial Lecture on the subject of the exploitation of rare metals.

Bermuda Conference

Everyone attending the Annual Meeting this year will have the opportunity to fly to Bermuda for a one-week postmeeting conference program. A special group price of $265 will cover all expenses. Full details are given on pages 204 and 205.

Technical Program

Following are the symposia and committee-sponsored sessions as they shape up at present. Details are subject to change.

Symposium on Soil Dynamics

Sponsored by Committee D-18 on Soils for Engineering Purposes.

Testing Procedure and Presentation of Data for Tradex Model Footing Vibration Tests—J. A. Alai, Radio Corporation of America.

In addition to the symposia listed here there will be sessions on:

Fatigue	**Testing**
Steel	**Non-ferrous Metals**
Cement	**Elevated Temperature**
Concrete	**Road and Paving Materials**
Soils	

Annual Meeting Program (continued)

Biaxial Stress Fields in Noncohesive Soils Subjected to Vibratory Loads—R. K. Bernhard, Rutgers University.
Stress-Deformation Relations for Soil Under Low-Frequency Oscillating Direct Shear Forces—F. J. Converse, Converse Foundation Engineering Co.
Dynamic Loading Device and Results of Preliminary Small Scale Footing Tests—R. W. Cunny and R. C. Sloan, U. S. Army Engineers Waterways Experiment Station.
Performance of Embedded Pressure Gages Under Static and Dynamic Loadings—A. J. Durelli and W. F. Riley, Armour Research Foundation.

Analytical Model for Response of Foundations to Dynamic Load—E. T. Selig, Armour Research Foundation.
Bearing Capacities of Dynamically Loaded Footings—S. Shenkman and K. E. McKee, Armour Research Foundation.
Facilities for Dynamic Testing of Soils—G. K. Sinnamon and N. M. Newark, University of Illinois.
The Damping Capacity of Some Granular Soils—G. F. Weissmann and R. R. Hart, Bell Telephone Laboratories.

Symposium on Impurities in Steam

Sponsored by Committee D-19 on Industrial Water.

Introduction—J. K. Rice, Cyrus Wm. Rice & Co.
Improved Techniques for Sampling Steam—E. E. Coulter and R. V. Cobb, Babcock & Wilcox Co.
Volatility of Sodium Chloride from High-Pressure Boiler Water (Research Contribution of Committee D-19)—M. M. Rubright, The Babcock & Wilcox Co.
Impurities in Steam from High-Pressure Boilers—R. C. Ulmer and H. A. Klein, Combustion Engineering, Inc.
Summary—F. E. Clarke, U. S. Naval Engineering Experiment Station.

Symposium on Elevated Temperature Compression Testing of Sheet Materials

Sponsored by Joint Committee on Effect of Temperature on the Properties of Metals.

Rapid-Rate Compression Testing of Sheet Materials at High Temperatures—E. C. Bernett, Jet Propulsion Laboratory.
Evaluation of Test Variables in the Determination of Elevated-Temperature Compression Yield Strength of Magnesium Sheet—R. W. Fenn, Jr., The Dow Metal Products Co.
An Evaluation of Sheet Compression Testing Techniques at Elevated Temperatures—George Gerard, New York University.
Compression Testing of Sheet Materials at Elevated Temperatures—R. Papirno and G. Gerard, New York University.
Compression and Buckling Characteristics of Inconel 718—Georges Welter, Ecole Polytechnique.
An Evaluation of a System for the Compression Testing of Sheet Materials at Elevated Temperatures—W. W. Breindel, R. L. Carlson, and F. C. Holden, Battelle Memorial Inst.

Symposium on Evaluation of Metallic Materials in Design for Low Temperature Service

Sponsored by Joint Committee on Effect of Temperature on the Properties of Metals.

Factors Influencing the Fracture Toughness of Sheet Materials for Use in Lightweight Cryogenic Tankage—G. B. Espey, M. H. Jones, and W. F. Brown, Jr., National Aeronautics and Space Administration.
Steels of Improved Fracture Toughness—J. M. Hodge, U. S. Steel Corp.
The Effect of Small Cracks on the Load-Carrying Ability of High-Strength Steel—G. K. Manning, Battelle Memorial Inst.
Design of Cryogenic Storage for Industrial Applications—H. W. Marsh, Graver Tank and Manufacturing Co.
Effect of U-Notch Depth on Impact Resistance Under Simple Beam Loading—D. C. Reymond, Esso Research and Engineering Co.
Mechanical Property and Structural Component Testing Techniques and the Evaluation of Design Allowables for Use at Liquid Hydrogen Temperatures—F. Schwartzberg and R. Markovich, The Martin Co.
Brittle-Fracture Transition of Some Concrete Reinforcing Steels—A. L. Tarr, U. S. Army Research Office.
The Correlation of Notch:Unnotch Tensile Ratios with Tensile Fatigue Properties of Complex Welded Joints in High-Strength 300 Series Stainless Steels at Cryogenic Temperatures—J. F. Watson, T. T. Tanalski, and A. Hurlich, Convair Astronautics.
Analysis of the Effects of Test Temperature on the Notch Strength of High-Strength Sheet Alloys—V. Weiss, Syracuse University.
Welded Ferritic Steel Constructions for Intermediate Low-Temperature Service. Considerations Arising from Tensile Tests on Welded and Notched Wide Plates—A. A. Wells, British Welding Research Assn., and J. W. Strawson, Shell Refining and Marketing Co., Ltd.
Testing and Design Considerations for Brittle Fracture—Sumio Yukawa, General Electric Co.

ASTM Post-Annual Meeting

Conference in Bermuda

June 30—July 7, 1961

For those who wish to extend their Annual Meeting plans in Atlantic City this year, the Philadelphia District, through Embassy Tours, has arranged an interesting and exciting post meeting conference program in Bermuda.

Air-conditioned charter buses will be waiting for you at Haddon Hall in Atlantic City on June 30 to whisk you to Idlewild Airport in New York in time to board Cunard Eagle Airways Flight 108 to Bermuda. Meal service and swizzles in flight, and in three hours you will be in Bermuda enjoying the luxury of the world-famous Princess Hotel and Beach Club. For eight days and seven nights you will be wined and dined and pampered . . . a relaxing world of sports and fun is waiting to be explored and enjoyed. On Saturday morning you will be escorted by private cars on a fabulous three-hour tour of the island with special emphasis placed upon new building construction and new methods which have been found to house and maintain this active tiny British island. Sunday is free for adventure or relaxation on the pink beaches of Bermuda. Morning conference on Monday with a short talk offered by one of the island's leading personalities. Wednesday, a never-to-be-forgotten, all-day Island cruise aboard the Yacht, *Duchess*. Barbecue luncheon with calypso entertainers on your own coral island with a homeward bound swizzle party. Thursday evening a cocktail reception and gala last night farewell party. Outdoor buffet dinner and more of that wonderful calypso music. Depart Friday to arrive in New York about 8:30 p.m.

Included in the Special Group Price:

- Charter bus to Idlewild and round-trip air transportation New York to Bermuda.
- Round-trip private car transfers.
- Twin-bedded rooms with private bath at the swank Princess Hotel.
- Breakfast and dinner daily, and gala reception with outdoor buffet.
- All sightseeing and yacht cruise.
- All hotel gratuities.

$265

per person

Symposium on Erosion and Cavitation

Sponsored by Administrative Committee on Simulated Service Testing.

The Deformation of Solids by the Impact of Liquids at High Speeds—J. H. Brunton, University of Cambridge.
Erosion by Liquid Impact—S. M. DeCorso, Westinghouse Research Laboratories.
Accelerated Cavitation Erosion and Sand Erosion—W. C. Leith and W. S. McIlquham, Dominion Engineering Works.
Cavitation in Hydraulic Turbines—W. J. Rheingans, Allis-Chalmers Manufacturing Co.

Symposium on Radiation Effects in Refractory Fuel Components

Sponsored by Committee E-10 on Radioisotopes and Radiation Effects.

Concerning the Effects of Excess Oxygen in UO_2—J. A. L. Robertson, Atomic Energy of Canada Ltd.
Void Formation in Irradiated UO_2—J. L. Bates, General Electric Co.
The Heat Rating Required to Produce Central-Melting in Various UO_2 Fuels—A. S. Bain, Atomic Energy of Canada, Ltd.
Fission Fragment Tracks in UO_2—T. S. Noggle, Oak Ridge National Laboratory.
Sintering Characteristics in a Radiation Environment—E. A. Aitken, General Electric Co.
Study of the Factors Controlling the Release of Xe^{133} from Bulk UO_2—D. F. Toner and J. L. Scott, Oak Ridge National Laboratory.
In-Pile Release of Fission Products in UO_2—J. B. Melehan, S. G. Epstein, and F. A. Rough, Battelle Memorial Inst.
The Continuous Release of Fission Gas from UO_2 During Irradiation—R. M. Carroll, Oak Ridge National Laboratory.
Irradiation of BeO-UO_2 Fuel Pellets—D. E. Johnson, J. Koretzky, and A. K. Smalley, Battelle Memorial Inst.
Radiation-Induced Damage in Uranium Monocarbide—D. G. Freas, A. E. Austin, and R. A. Rough, Battelle Memorial Inst.
Effects of Burnup on Certain Ceramic Fuel Compounds—M. L. Bleiberg, Bettis Atomic Power Laboratory.
Hydrolysis of Beryllia—C. C. Browne, General Electric Co.
Irradiation Behavior of PuO_2–UO_2 Fast Oxide Breeder Fuel—J. N. Sittanen, J. M. Gerhart, and J. S. Cochran, General Electric Co.

Symposium on Extension of Sensitivity for Determining Various Constituents in Metals

Sponsored by Committees E-2 on Emission Spectroscopy and E-3 on Chemical Analysis.

Paper by J. L. Hague, National Bureau of Standards.
Recent Developments in Electroanalytical Chemistry—L. Meites, Polytechnic Institute of Brooklyn.
Radioactivation Analysis: A Sensitive and Specific Method for Metals Analysis—G. W. Leddicotte, Oak Ridge National Laboratory.
Ultratrace Emission Spectroscopy—G. H. Morrison and R. L. Rupp, General Telephone and Electronic Laboratories.
Use of the Electron Probe to Measure Low Average but High Local Concentrations—L. S. Birks and R. E. Seebold, U. S. Naval Research Laboratory.
High-Sensitivity Analysis of Impurities in Solids by Mass Spectrometry—C. M. Stevens, Argonne National Laboratory.

Symposium on Microviscometry

Sponsored by Committee D-4 on Road and Paving Materials.

The Effects of Viscosity in Hot-Mix Construction—Verdi Adam, State of Louisiana Department of Highways.
Measurement of Consistency of Paving Cements at 140 F with the Sliding-Plate Microviscometer—R. W. Griffin and D. F. Fink, Shell Development Co.
Relation Between Thin-Film ($\frac{1}{8}$-in.) Oven Test and Microfilm Aging Index—W. J. Halstead and J. Zenewitz, U.S. Bureau of Public Roads.
The Precision of Measurements with the Sliding-Plate Microviscometer—D. F. Fink and J. J. Heithaus, Shell Oil Co.
The Rheology of Asphalt-Filler Systems as Shown by the Microviscometer—R. S. Winniford, California Research Corp.

Symposium on Major Effects of Minor Constituents on Properties of Materials

Sponsored by the Division of Materials Sciences.

Titles of the following papers are not yet definite. Shown in italics are the topics, rather than exact titles.

Effects of Minor Constituents on Properties of Solid Organic Materials and Polymers—J. F. Lontz, E. I. du Pont de Nemours & Co., Inc.
Effects of Minor Constituents on Properties of Ionized Gases (Plasmas)—S. J. Buchsbaum, Bell Telephone Laboratories, Inc.
Effects of Minor Constituents on Properties of Organic Liquids—H. M. Smith, U. S. Bureau of Mines.
Effects of Minor Constituents on Properties of Ceramic Materials—I. B. Cutler, University of Utah.
Impurity Effects in High-Purity Metals—G. A. Moore and L. L Wyman, National Bureau of Standards.

BERMUDA BEACHTIME

There are a dozen miles of beaches in mid-Atlantic Bermuda. And many of them, like the one above, are divided by romantic coral cliffs into protected little coves. The water of Bermuda is unsurpassed both for clarity and color.

an Embassy Holiday

Return to:
Thomas A. Marshall, Jr., Executive Secretary
American Society for Testing Materials
1916 Race Street
Philadelphia 3, Pa.

Enclosed is my deposit of $_____ ($50 per person) for _____ (number of persons) for the ASTM post-Annual Meeting conference in Bermuda, June 30–July 7, 1961. I will remit full payment no later than May 15, 1961.

Name_____

Address_____

_____

All deposits must be received by April 15. Please make checks payable to the American Society for Testing Materials.

Symposium on Materials and Electron Device Processing

Three-day national technical meeting set for first week in April

A THREE-DAY symposium on "Materials and Electron Device Processing" will be held at the Benjamin Franklin Hotel, Philadelphia, Pa., on April 5-7, 1961, under the auspices of ASTM Committee F-1 on Materials for Electron Tubes and Semiconductor Devices, Subcommittee X on Control of Contaminants. D. E. Koontz, Bell Telephone Laboratories, Inc., is symposium chairman.

Subjects to be covered in the 35 papers over the three-day period will include control of ultraclean device assembly areas, new techniques for the detection of trace contaminants, advanced device cleaning processes, and reports on the effects of such cleaning on device performance. Also to be included are discussions of the characterization and control of gaseous and vacuum processing ambients, as well as safe handling practices and uses of beryllia ceramics. The topics to be covered are of great interest and importance in the electronics industry, but beyond that, other industries such as drugs and fine machinery are concerned with similar problems and will, no doubt, profit from participation in the symposium.

Cooperating with Committee F-1, the Philadelphia District Council will sponsor a dinner meeting Thursday, April 6. John W. Campbell, editor of *Analog—Science Fact and Fiction*, will speak on "Orthodoxy in Science."

Those interested in attending the symposium may get information on registration and hotel reservations by writing to ASTM Headquarters.

The program is as follows:

Wednesday, April 5, 10:00 a.m.

Session Chairman, N. L. Hobbs, Wyeth Laboratories.

Introduction

The Control of Impurities in Impurity-Dominated Electronic Materials and Devices—F. J. Biondi, Bell Telephone Laboratories,

Air-borne Contaminants

Particulate Concentrations in Ultra-Clean Rooms, Part I—F. Van Luick, General Electric Co.

Particulate Concentrations in Ultra-Clean Rooms, Part II—F. Van Luick, General Electric Co.

A Comparison of Electrostatic and Absolute Air Filters for Clean Room Service—George Helmke, Bell Telephone Laboratories, Inc.

Dust Monitoring by the Dry-Slide Settling Technique—W. J. Whitfield, Sandia Corp.

An Approach to Control of Transistor Processing Environments—C. A. Smith and T. Manns, Philco Corp.

Wednesday, April 5, 2:00 p.m.

Analytical Methods and Instrumentation

Session chairman, F. Van Luick, General Electric Co.

Electrobeam Microanalyzer—A New Tool for Electron Device Development—J. S. Hayes, Bell Telephone Laboratories.

Determination of Inorganic Contaminants on Metal Surfaces by an EMF Measurement—D. Schimmel, Sylvania Electric Products.

Electrode Potential: A Tool for the Control of Materials and Processes in Electron Device Fabrication. Part I: EMF-Time Studies of Clean and Contaminated Platinum Electrodes—D. O. Feder and E. S. Jacob, Bell Telephone Laboratories, Inc.

Electrode Potential: A Tool for the Control of Materials and Processes in Electron Device Fabrication. Part II: EMF Studies of the Behavior of Iron-Nickel Alloys in Hydrogen Peroxide-Formic Acid Etchants—D. O. Feder and W. Howden, Bell Telephone Laboratories, Inc.; D. R. Huff, Southern Bell Telephone and Telegraph Co.; and J. W. Richards, Chesapeake and Potomac Telephone Co. of West Virginia.

Use of Tracer Techniques in Contamination Studies—T. J. Bulat, The Bendix Corp.

Gas Phase Proportional Counting: A Radiotracer Technique to Examine Electron Devices and Materials—H. A. Stern, Radio Corporation of America.

Thursday, April 6, 9:00 a.m.

Processing Apparatus and Techniques

Session chairman, H. A. Stern, Radio Corporation of America.

Fluorine Release from Glasses—Josef Francel, Owens-Illinois Glass Co.

Arc Sealing of Borosilicate Glass—M. Liebson, U. S. Army Signal Corps.

Elimination of Contaminants from Electron Tube Components: Automation of Chemical Processing—C. O. Thomas, W. H. Craft, D. E. Koontz, Bell Telephone Laboratories, Inc.

Transducer Parameters Affecting Sonic Cleaning—L. J. Lyons, The Bendix Corp.

Removal of Water-Soluble Flux from Printed Circuit Boards and Electrical Components—J. E. Smallwood, The Bendix Corp.

Use of Ultrasonics in the Cleaning of Printed Circuit Boards—G. B. Hollerith, Bronson Instruments.

Thursday, April 6, 2:00 p.m.

Materials and Processing Techniques

Session chairman, J. Lineweaver, Corning Glass Co.

Recommended Practices for Safe Handling of Beryllia Ceramics, Part I—L. Ferreira, Coors Porcelain Co.

Recommended Practices for Safe Handling of Beryllia Ceramics, Part II—L. Ferriera, Coors Porcelain Co.

Beryllia Oxide Dielectric—Heat Sinks for Electronic Devices—P. Hessinger, A. Strott, and B. Haura, National Beryllia Corp.

Sulfamic Acid Cleaning of Electron Tube Parts—R. Etler, Radio Corporation of America.

A 24-Position Semiautomatic Vacuum Tube Exhaust Machine—L. T. Quoglia and George F. Reyling, Varian Associates.

Purification, Distribution, Control, and Monitoring of High-Purity Gases for Electron Device Processing—D. T. Manus, Texas Instruments, Inc.

Friday, April 7, 9:00 a.m.

Gaseous Contaminants

Session chairman, V. C. Smith, Barnstead Still and Sterilizer Co.

Comparison of Standard Leak Rates Measured by Different Techniques—D. W. Maurer, Bell Telephone Laboratories, Inc.

Gas Composition During Pumping and in Sealed-off Power Tubes—P. J. Varadi, H. A. Langer, and M. V. Saltzman, Machlett Laboratories, Inc.

Detection of Trace Amounts of Oxygen in Protective Gaseous Ambients—D. O. Feder and W. H. Craft, Bell Telephone Laboratories, Inc.

Outgassing Caused by Electron Bombardment of Glass—J. Lineweaver, Corning Glass Works.

Getters—Quality Control—P. Della Porta and E. Airoldi, SAES Getters, Milan, Italy.

Residual Gas Levels as a Function of Tube Processing—H. B. Frost, Bell Telephone Laboratories, Inc.

Friday, April 7, 2:00 p.m.

Influence of Cleaning on Device Performance

Session chairman, D. E. Koontz, Bell Telephone Laboratories, Inc.

Relationship of Germanium-Alloy Transistor Reliability to Etching, Washing, and Encapsulating Processes—A. J. Borofsky, Sylvania Electric Co.

Process Variables and Their Influence on the Gas Content of Anode Materials—B. J. Bliss, Texas Instruments, Inc.

Effect of Various Cleaning Methods on Electronic Components in the Micromodule—J. L. Vossen, Radio Corporation of America.

Problems Related to Parts, Cleaning, and Firing—R. P. Misra and R. R. Mix, Texas Instruments, Inc.

Noise Tested Cathode Activation—F. Dlouhy and H. J. Schütze, Telefunken, Stuttgart, Germany.

Report on Committee Week

THE MAN IN THE STREET has no doubt never heard of ASTM Committee Week. Any connection between his everyday way of life and the goings on in Cincinnati the first week of February would probably seem remote. Still, he owes much to the work of the technical committees, who help to provide the materials that contribute to the highest standard of living he has ever known—his home, his car, his clothing, fuels to keep him warm, refrigeration to keep him cool, fire-resistant materials for greater safety, and many other things.

Thirty-two of the Society's main technical committees and over 360 subcommittees met during Committee Week, January 30 to February 3, at the Netherland Hilton Hotel in Cincinnati. Progress reported by the 1222 hard-working individuals present is summarized in the following pages.

The members of the Ohio Valley District were sponsors of the annual Committee Week Dinner on Wednesday, February 1. Bernard B. Berger, chief of water supply and pollution control research for the Robert A. Taft Sanitary Engineering Center, spoke about the work of the Center relating to stream pollution and the control of water quality. The social, political, legal, economic, and technical factors are so intertwined that they are challenging the best minds in these fields. Among the more serious problems is an evaluation of our ability to continue to cope with the increasing sources of pollution and to monitor their effects in our streams. For example, Mr. Berger raised the question of whether or not the increase in the number of outboard motors would create conditions in our rivers and lakes akin to the smog resulting from automobile exhausts and other air pollutants which now plague some of our cities. Such a development could have an extremely detrimental effect on marine life and on public water supplies.

E-10 Task Group Studying Space Radiation Effects on Materials

WHAT INTERACTION exists between temperature, pressure, and radiation damage? What correlation exists between damage from proton radiation and from other types of radiation? How serious is possible buildup of electrostatic charge on the antenna of a space ship in an electron field? Would the impact of micrometeorites serve to bleed off such a charge?

These and similar questions were asked at the first meeting of the Space Radiation Study Group of Committee E-10 on Radioisotopes and Radiation Effects, in Utica, N. Y., January 11. Formed to add to our understanding of radiation damage in materials and thereby to establish a basis for predicting radiation effects on components and systems, the group agreed at its first meeting to limit its studies to naturally occurring space radiation. Effects of weapon bursts, nuclear reactor radiation, and biological problems will not be touched on, since they are being adequately covered elsewhere.

The group set up four subgroups on:

1. Space environment (radiation; temperature; pressure; aggregate particles; electromagnetic fields; electrostatic effects; and vibration, shock and other man-made effects).
2. Radiation effects on materials, and from this the prediction of its effects on components, devices, and systems.
3. Facilities for testing.
4. Information sources and liaison.

Proceedings of the first meeting of the task group were reported at the meeting of Committee E-10 during Committee Week. Final reports of the four subgroups will be presented at a panel discussion planned for the 1961 Annual Meeting of the Society in June. Chairman of the task group is Robert S. Shane, General Electric Co., Utica, N. Y.

Tests for Radioisotope Purity, Assay Procedures Drafted

The first two in a series of proposed methods dealing with tests for the purity of radioisotopes and assay procedures have been drafted by Committee E-10. These are "Method for General Procedures for Radioisotope Analysis" and "Method for Analysis of Phosphorus-32." The first contains a number of commonly used techniques of radioactive measurement and will serve as a general reference for other methods using such techniques.

New Task Group To Encourage Use of Radioisotopes in Materials Testing

A task force of Subcommittee III on Tracer Applications of Committee E-10 will actively pursue the promotion and knowledge of radioisotopes in the testing of materials. Recognizing that a group of this nature has long been needed, Committee E-10 authorized its appointment on February 1. W. S. Lyon, Oak Ridge National Laboratory, Oak Ridge, Tenn., is chairman of the group and will welcome correspondence with anyone interested in this activity.

To Recommend Practices for Determining Radiation Effects in Inorganic Materials

A program for preparing recommended practices for determining radiation-induced changes in inorganic materials has been announced by the Inorganic Materials Task Force of Subcommittee II of Committee E-10. Recommended practices will be developed for determining the high-energy-radiation-induced changes in:

1. Thermal, impact, and electrostatic sensitivities of inorganic oxidants and fuels.
2. Electrical properties and catalytic activity of surfaces of inorganic materials.
3. Stability of inorganic surface coatings.
4. Reactivity of inorganic materials which undergo induction periods prior to decomposition.
5. Displacement defects in inorganic solids (radiation annealing).

Those actively engaged in research on effects of radiation on inorganic materials who wish to contribute to the above program or to suggest other similar test procedures for standardization should get in touch with the task force chairman, Eli S. Freeman, Pyrotechnics Chemical Research Laboratory, Picatinny Arsenal, Dover, N. J.

Studies of Reactor Materials

Being considered for publication by Committee E-10 are two recommended practices intended to increase the usefulness of data obtained in the field of radiation effects on metals. One is for determining the effect of high-energy radiation on the tensile and impact properties of metals and the other is for surveillance tests on structural materials in nuclear reactors.

The first recommended practice covers procedures for tension and impact testing of irradiated metals with special attention to the selection of material and tests for irradiation studies, the determination of irradiation conditions, and the reporting of data. While primarily intended to apply to steels, the practice may be applied where appropriate, to any metal. In addition to tension and impact testing, the recommendations should be of help in planning other types of radiation-effects testing.

Several reactor designers are providing space for insertion of impact and tension specimens made from steel used in the reactor pressure vessel or internal structural components. Periodically, these specimens will be removed from the reactor and tested to determine the extent to which the reactor radiation may have embrittled the steel. The second recommended practice covers procedures for irradiating and testing such specimens so that the information obtained will be of greatest possible value to the reactor designer and, if published, to the nuclear industry.

To help implement these two recommended practices, United States Steel Corp. has offered to provide standard reference steels to be used as correlation monitors in research and surveillance programs. By irradiating this reference material in different reactors, the influence of variations in neutron dose rate and spectrum can be evaluated. To date, samples of the reference steels have been supplied to Argonne National Laboratory, Bettis Atomic Power Laboratory, Brookhaven National Laboratory, Naval Research Laboratory, Oak Ridge National Laboratory, and Westinghouse Atomic Power Dept. In addition, inquiries regarding this material have been received from investigators in England and Switzerland.

Other Activities

Several documents covering the measurement of radiation effects on vulcanized rubber have been referred to the rubber committee for its consideration. These are a proposed recommended practice for compression-set testing of vulcanized rubber during high-energy radiation, a proposed method for post-irradiation tension testing of vulcanized rubber, and a proposed method of test for compression set of vulcanized rubber exposed to high-energy radiation.

In the very important area of dosimetry, three documents are being reviewed by Committee E-10 for publication in 1961. These include a recommended practice for measuring neutron flux environment for reactor irradiated specimens, a method of test for fast neutron integrated flux by radioactivation of nickel, and a method for the radiochemical determination of cesium-137 in aqueous solutions.

Session on Fire Test Methods

The techniques and evaluation of fire tests in terms of actual performance are of concern to the entire construction materials field. ASTM standard methods of test for the establishment of fire ratings on construction materials are referred to in many building codes. There is a very definite need for test procedures using small-scale apparatus in evaluating building materials during the development stage. A group of four papers on fire tests were presented at a committee week session sponsored by Committee E-5 on Fire Tests of Materials and Construction. A. T. Robertson, National Bureau of Standards, and chairman of the Committee E-5 Subcommittee on Research, presided.

The first paper reviewed the early history of fire endurance testing in the United States. Harry Shoub, National Bureau of Standards, stated that the first record of a fire test requirement appears in an 1899 New York City building code. He then described the sequence of test programs developed throughout the country since that date.

T. Z. Harmathy, National Research Council of Canada, cited three approaches that have been made in the prediction of fire test results, one being strictly empirical and the other two analytical methods.

A new beam furnace recently put into operation at the Portland Cement Laboratories was described by P. J. Tatman. This installation represents one of the first major efforts to develop information on the behavior of concrete shapes under exposure to fire.

J. A. Wilson, Factory Mutual Engineering Div., presented a survey of test methods and a comparison of results from several types of apparatus designed to measure surface flammability of materials in this country, Great Britain, Australia, and in Denmark. Probably the best known of the currently used tests for evaluating this property is the tunnel test, originally developed by the Underwriter's Laboratories in 1941 and published by ASTM in 1950.

Fire Test Correlation Data Accumulating

Reports to Committee E-5 on Fire Tests of Materials and Construction indicate that the dearth of correlation test data for the large tunnel test (E 84), the small tunnel test (published as information only), and the radiant panel test (E 162) is rapidly being overcome. Correlation was reported on Method E 84 between the Underwriters' Laboratories in Chicago and the Underwriters' Laboratories of Canada. Three new installations of the small (8-ft) tunnel test apparatus were reported. A series of round-robin tests have been completed on the radiant panel test by Committee C-16 on Thermal Insulating Materials, with suggested revisions being presented to Committee E-5 for consideration. Another series of tests on the radiant panel apparatus is being sponsored by the Insulation Board Inst.

Additional definitions of terms were approved for ignition, self-heating, self-ignition, and self-ignition temperature. The committee reaffirmed its acceptance of definitions of terms for fire endurance, fire resistance, and noncombustibility, after consideration of negative votes.

Man's Senses To Be Compared with Man-Made Instruments

Committee E-18 on Sensory Evaluation of Materials and Products will evaluate the human senses as an instrument for gathering data about materials. The committee will compare the range, validity, and sensitivity of sensory measurements with results of measurements on the same materials using instruments. A long-term objective will be the correlation of instrument methods with sensory methods so that either may be used interchangeably to evaluate properties of a sensory nature —taste, odor, sound, feel, appearance. The committee will emphasize, for the present, studies relating to taste and odor as applied to engineering materials.

The Subcommittee on Principles of Psychophysical Testing, E. E. Lockhart, chairman, has organized several sections covering fundamental physiology, fundamental psychological laws, measuring techniques, design of experiments, and experimental techniques. The subcommittee will be concerned with the effects of environment on the response of the observer to stimuli, as well as other factors which influence results.

The Subcommittee on Preparation of Recommended Practices, Frank Pilgrim, chairman, will coordinate its work with Dr. Lockhart's group but will be concerned with the more practical aspects of psychophysical testing. The Subcommittee on Instrumental Sensory Relationships, Robert Baker, chairman, will collect information on correlations of sensory and instrument measurements, confining its initial activities to the fields of taste and odor.

The committee will not confine its work entirely to studies with humans but, where appropriate, will use other living subjects such as insects which have been shown to have definite responses to stimuli that can be measured with instruments. For example,

substances can be analyzed by gas chromatography, these substances causing a very definite observable response in cockroaches exposed to them. In this case, a cockroach might quite appropriately act as a transducer in a measuring system, with results comparing with those obtained with a gas chromatograph.

Officers of the committee are Amos Turk, consultant, chairman; H. L. Stier, National Canners' Assn., vice-chairman; and Mrs. Mavis B. Carroll, Research Center, General Foods Corp., secretary.

Thomas Urges More Sulfuric Acid Measurements in Atmosphere

Studies give evidence of rather important physiological effects of sulfuric acid in the atmosphere. At a meeting of Committee D-22 on Methods of Atmospheric Sampling and Analysis, M. D. Thomas pointed out that while sulfur dioxide can exist in the atmosphere as such, sulfur trioxide does not exist in the atmosphere but when present is in the form of sulfuric acid. He urged the committee to place more emphasis on measurements of sulfuric acid content in the atmosphere so that a backlog of information would be built up for correlation with observed physiological effects. Better analytical methods and recorders are needed to measure the sulfuric acid content. The committee agreed to consider a draft method for sulfuric acid to be prepared by Dr. Thomas.

The committee has prepared a rather extensive list of units and conversion factors used in atmospheric analysis and will recommend its publication. The list may be useful to many other committees of the Society as a standard reference for these conversion factors.

A proposed new tentative method for particulate matter in the atmosphere using the principle of light scattering will be recommended to the Society in the annual report of Committee D-22.

New task groups are developing methods for organic lead content, formaldehyde, acrolein, and polynuclear hydrocarbons in the atmosphere.

The committee has discussed with the American Public Health Assn. and others the need for a comprehensive manual on examination of the atmosphere. These discussions will continue with the objective of coordinating all the major national interests in the field of atmospheric studies.

Skid Resistance Committee Forms Subcommittees

Seven subcommittees were organized by the new committee E-17 on Skid Resistance at its first meeting since its organization in June, 1960. Subcommittees and their chairmen are:

Papers and Symposia, W. H. Goetz, Purdue University.
Definitions and Nomenclature, C. R. Foster, National Bituminous and Concrete Assn.
Field Tests, T. E. Shelburne, Virginia Council of Highway Investigation and Research.
Laboratory Methods, W. A. Goodwin, Tennessee Highway Research Program.
Laboratory-Field Coordination, R. M. Galloway, Texas A&M College.
Tire Characteristics and Significance, L. F. Rader, University of Wisconsin.
Fundamental Factors, R. F. Baker, Ohio State University.

An additional subcommittee, on Floor Surface Slipperiness, will be formed later. However, an informal meeting was held on this subject with interested members of Committee D-21 on Wax Polishes present.

Interest on an international level was evidenced by communications read at the meeting from the International Association of Road Congresses and from a report presented by H. K. Bourne, representing C. G. Giles of the British Road Research Laboratory.

Appearance Manual Planned

Committee E-12 on Appearance has completed a proposed general guide for use in selecting measurement scales and instrumentation for describing such appearance characteristics as glossiness, opaqueness, lightness, and haziness in terms of reflected or transmitted light. This guide does not consider spectral variations responsible for color, since chemical values of color often depend importantly on geometric factors.

The committee has had under discussion the preparation of a manual on appearance control. This manual is intended to summarize the basic principles underlying appearance, its control, and its measurement. It will be useful as a guide in the development of systems that are flexible enough to meet the needs of special problems without the introduction of undue complexity. As an aid to the reader in solving his problems, illustrative examples will be included, although the treatment of all problems in great detail will not be possible within the confines of this manual. It is hoped to get this project under way shortly.

A very active program is under way on developing test methods for measuring the appearance of typewriter ribbons and carbon papers. In interlaboratory test program just completed impression transfers from typewriter carbon paper and ribbons were evaluated by six different instruments. Further tests will be made.

First Thermocouple Standards in Preparation

The increasing use of materials at high temperatures in missile and nuclear power applications has made new demands on thermocouples for such applications. Also an increasing number of ASTM methods are specifying thermocouples for temperature measurement. The requirements now specified have been reviewed, and a paper on "Thermocouples and Their Usage in ASTM Standards," will be submitted for possible publication in *MR&S*.

A manual now in preparation will present up-to-date information on the newer thermocouple materials as well as standard thermocouples. This monograph on the use of thermocouples will present current information on emf measurement; principles of thermoelectricity; thermoelectic materials; and fabrication, installation, and use of all types of thermocouples. Standard methods are now under development for the comparison calibration of thermocouples and for testing thermocouple element materials by comparison to a secondary standard of similar composition.

New Definitions with Procedures Relating to Conditioning and Weathering (E 41) and Specifications for Standard Atmospheres for Conditioning and Testing Materials (E 171) have been completed. It is hoped that these definitions and standard conditions for laboratory testing will be used by all other ASTM committees. The specifications for enclosures and servicing units other than ovens for tests above and below room temperature (D 1197) were revised.

The Subcommittee on Low Temperature Testing of Elastomers and Plastics has in preparation a final report which will summarize the extensive data that had been obtained in the comprehensive interlaboratory studies conducted over the past seven years on stiffness, hardness, rheological testing, and brittleness testing of elastomers and plastics.

The Subcommittee on Calibration of Mechanical Testing Machines and Apparatus is working on the problem of developing a method for verification of testing machines at rapid rates of straining. At present there is no suitable method.

The Subcommittee on Elastic Properties and Definitions of Mechanical Testing is planning further changes in the Definitions of Terms Relating to Methods of Mechanical Testing (E 6) looking toward the standardization of mechanical testing terms common to metals, plastics, and other nonmetallic materials in order to avoid conflicting practices.

The new Task Group on Linear Thermal Expansion Test is making a review to determine the need for thermal expansion methods in various industries. It is expected that this review will develop valuable information regarding

accuracy, temperature ranges, sample and specimen sizes required, and other important details regarding expansion measurement techniques.

Fatigue Laboratory Techniques

Committee E-9 on Fatigue formed a new Subcommittee on Apparatus and Methods for Fatigue Evaluation. This group will study and make available to industry information concerning new laboratory techniques in fatigue evaluation of materials and structures.

The committee formulated plans for strengthening their communication with foreign corresponding members. These correspondents from France, Australia, England, Sweden, Japan, and Germany report periodically to the committee the significant developments in fatigue research in their respective countries.

Following the business meeting, Bradley Schofield, of Lessells and Associates, gave a talk on "Acoustic Emission Under Applied Stress." This included a magnetic tape recording of noises emitted by metals under stress, and tentatively ascribed to movement of dislocations in the metal crystals.

Solvents Committee Defining Its Terms

The terms being defined by Committee D-26 on Halogenated Organic Solvents reveal the area of interest of the committee and include safety solvents, toxicity, dermatitis, occupational dermatosis, health hazards, combustibility, flammability, etc. In the solvents industry, a major objective is safe use of cleaning solvents. This means minimizing both toxicity and flammability hazards. The committee will make a big contribution toward assisting the solvent-using industries in the safe handling of solvents by publication of a manual on vapor degreasing which is expected within the year. The manual will cover the major considerations involving vapor degreasing equipment, the handling and use of solvents, and general aspects of vapor degreasing. Since the manual is being prepared by a balanced group of equipment and solvent producers and users, it should reflect the best thinking in the industry on this subject.

In the missile industry there are problems in cleaning out empty fuel systems, particularly those which contained liquid oxygen. The solvents used for this purpose must be exceptionally free of impurities or suspended particles, and the committee is developing a specification for trichloroethylene for this type of application.

Elsewhere in the committee, other uses of solvents are being considered, particularly cold cleaning. One group is working toward a manual on cold cleaning which will cover methods of use—that is, spray, dip, wipe, ultrasonics; end-use applications, including the substrate material being cleaned; types of solvents and their physical and chemical properties. The manual will also set conditions of use from a safety point of view, including problems of flammability and toxicity.

A new Subcommittee on Dry Cleaning will coordinate its work with a similar subcommittee under Committee D-12 on Soaps and Other Detergents.

Test for Friction of Waxed Floors Nears Completion

Committee D-21 on Wax Polishes and Related Materials is submitting for publication as tentative the proposed methods of test for measuring the static coefficient of friction of waxed floor surfaces published as information in the ASTM Bulletin in February, 1954. Considerable interlaboratory work by several cooperating laboratories has established a background of data and the limits of this test method.

New methods in preparation cover the determination of silicones in solvent-type wax polishes and freeze-thaw stability of floor waxes.

A new recommended practice for maintaining a wax surface on vinyl asbestos tile has been developed. The committee hopes to develop suggested recommended practices for maintaining wax polishes on a variety of floor surfaces that will be of advantage to the users of floor waxes. One for asphalt tile was recently completed and others are in preparation.

Coal Committee Forms Statistics Subcommittee

Committee D-5 on Coal and Coke organized a new subcommittee on statistics to establish uniform practices within the committee for obtaining and analyzing data on precision of coal and coke test methods. The coal classification subcommittee was reactivated to review existing standards on classification of coal and will review and explore new developments in both domestic and foreign coal classification. Special attention will be given to the evaluation of coal for various uses on the basis of its chemical, petrographic, and physical characteristics.

Reports were made by two Committee D-5 members who attended the ISO/TC 27 meetings in Madrid, Spain, of working groups on coal sampling and coke testing. European techniques and test procedures are now being reviewed by the committee.

Proposed standard procedures are being prepared for measuring the expansion properties of heated coals by the moveable-wall oven and the sole-heated oven.

To Set Standards for Analysis of Butyl Lithium

Butyl lithium is a glamour chemical. Hopes for it run so high that the three producers — American Potash and Chemical Corp., Lithium Corp., and Foote Mineral Co.—now have capacity to turn out 350,000 lb per yr in the face of 1960 sales of only 20,000 lb. Why? Butyl lithium competes with the Zeigler catalyst in the manufacture of synthetic "natural" rubber—stereospecific polymers of polyisoprene and polyisobutylene. The catalyst is used in concentrations of from 0.01 to 0.1 per cent of monomer. According to *Chemical and Engineering News*, the promising catalyst sold for $100 per lb only a couple of years ago, has now dropped as low as $5.50 per lb in large quantities. But of what interest is this in ASTM?

Standards Needed

The chemical, made by reacting butyl chloride with lithium in a hydrocarbon solvent, is said to be fairly stable at concentrations of about 20 per cent, as it is sold. But becaue of its instability and its high cost, there are special problems of analysis and understanding between buyer and seller. Committee E-15 on Analysis and Testing of Industrial Chemicals has therefore authorized a task group on butyl lithium under its products methods subcommittees. Its objective: to blend producer and consumer interests in setting standards for analysis of the chemical.

Another area for new work is in the development of analytical standardization relating to organic peroxides. Here, the committee, in organizing a task group on organic peroxides under its general methods subcommittees, has objectives beyond simple analysis of these chemicals. The group will also be concerned with methods for detecting extremely low levels of peroxides, where peroxide formation in certain compounds is the forerunner of chemical deterioration of the material. Also, because of relative instability of organic peroxides used widely for catalysts in the rubber and plastics industries, the committee will be concerned with criteria for safe handling.

Projects farther along include a draft now ready for committee ballot covering a recommended practice for developing precision data on chemical-analytical methods. Draft methods are circulating in the committee covering analysis of acids and alkalies and standardization of potassium thiocyanate and other reagents.

An extensive bibliography on sampling has been prepared to establish a base line for the development of stand-

ard bulk sampling methods for simple liquids and simple solids.

Rubber Committee Hears Paper on Interlaboratory Testing

Committee D-11 on Rubber and Rubber-Like Materials heard a technical paper on "Interlaboratory Studies of Test Methods" presented by John Mandel, National Bureau of Standards. Mr. Mandel pointed out that the design of an interlaboratory study must be simple and flexible. Elaborate statistical designs are often highly vulnerable to the loss of even a single observation. Their validity also depends on a number of assumptions that do not always hold in individual cases. The basic design of a sound interlaboratory study of a test method involves nothing more than a collection of laboratories, a number of materials covering the range of interest, and the proviso that each laboratory measure each material more than once. This paper, in effect, was an introduction to work being undertaken by the committee in the development of a recommended practice on the planning of interlaboratory test programs for rubber.

Definition of the terms "rubber" and "elastomer" were approved for submission to letter ballot of Committee D-11 and Committee D-20 on Plastics.

The Subcommittee on Packings presented specifications for rubber rings for sealing joints in asbestos-cement pipe. These specifications include requirements for resistance to oil or solvents of natural and synthetic rubber rings.

A paper on "The Need for a Standard Method for Oil Aging of O-rings" was presented by H. G. Gillett of Precision Rubber Products Corp. The discussion that followed resulted in the appointment of a task group to develop a method for immersion testing of O-rings. This group will also consider the preparation of specifications for O-rings.

A new method of test for specific gravity of rubber chemicals was approved for publication. The committee will also develop a companion method for determining the apparent specific gravity of rubber chemicals.

The Subcommittee on Life Tests for Rubber Products presented a new method of test for tubular oven aging of elastomers and plastics. This method was prepared following results of tests obtained in a round-robin program. The test in this oven gave more reproducible results than tests made in ovens currently specified. Requirements for the oven will be submitted to Committee E-1 on Methods of Testing for review.

A new method of test for wire cord adhesion was submitted for publication as tentative. This method, which specifies pull-out test with two types of molds, was developed after round-robin tests with various molds conducted over a period of 20 months. A new method of test for textile cord adhesion was also submitted for letter ballot. This method has been developed in cooperation with Committee D-13 on Textile Materials.

The task group on methods for measuring the degree of pigment dispersion indicated that the prospects are good for developing both a quick and simple procedure and a more refined and more quantitative method for this measurement on vulcanized specimens. However, additional work is required to resolve differences in both procedures between laboratories before methods can be written, and also for unvulcanized specimens.

The SAE-ASTM Committee on Automotive Rubber reported completion of the following during the past year: A latex dipped goods specification and method of test, modifications of SAE 10R (Table VI on Polyacrylates), a specification for automotive air conditioning hose, a method of test for urethane foam, and changes in the vinyl foam specification to include flammability.

Effect of Temperature on Asphalt

The susceptibility of asphalt to temperature change, a significant property requiring an accurate testing procedure, is defined and measured by a new method prepared by the Subcommittee on Rheological Properties of Committee D-8 on Bituminous Materials for Roofing, Waterproofing, and Related Building or Industrial Uses. This method defines susceptibility in terms of the change of consistency with temperature. The property so defined is independent, for a given asphalt, of temperature and consistency over a wide range of practical application.

Two proposed specifications for bituminized-fiber drain and sewer pipe will be submitted to the Society. They cover laminated-wall and homogeneous bituminized-fiber drain and sewer pipe, respectively, the latter also including fittings.

Development of test methods for determining various properties of industrial pitches is progressing. The use of prefabricated asphalt material as a water-impervious layer, lining, or membrane for use in waterproofing reservoirs has led to consideration by the committee of a proposed specification for preformed asphalt board.

Fire Brick Classification

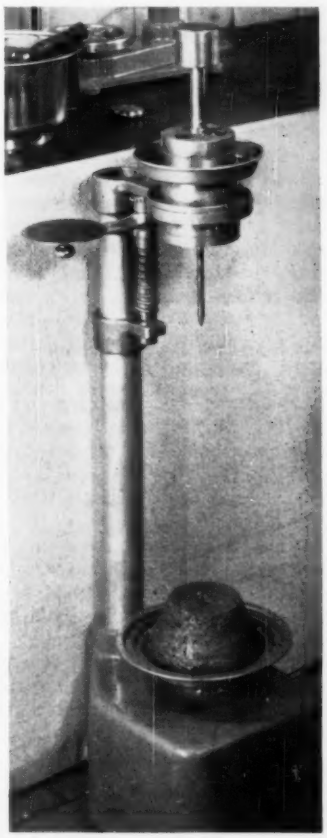
Interlaboratory data have been compiled by Committee C-8 on Refractories for establishing a new Group 30 insulating fire brick. Classification 155 will be revised to accommodate this new group, and Method C 210 will be revised to include a new heating schedule for it.

An interlaboratory study to establish correlation between long- and short-term load tests on semi-silica, mullite, and 60 per cent alumina refractory brick has been initiated. Two short-time load schedules have been proposed to provide data to correlate with existing long-time data in order to establish the schedule that may predict reliable long-time load information.

Four dynamic tests and one static simulated service test for the erosion of glass tank refractories are to be cooperatively tested by three laboratories. The resulting data will be used in the development of a laboratory scale test that will predict the erosion of refractories used in continuous container glass furnaces.

The incorporation of the Phelps consistency meter developed by the Refractories Institute Fellowship at Mellon Inst. has been completed after extensive laboratory development. This apparatus will be incorporated in Methods C 268 and C 269 (see cut).

A new classification covering mullite refractories has been developed based on hot-load test data. The classifi-



PHELPS CASTABLE CONSISTENCY METER.

cation will be presented for publication as tentative; however further data are being solicited for refinement of the classification.

A new section has been organized to cover test furnaces and controls for the development of laboratory data on refractories. The first investigation will be directed toward reheat test furnaces covering temperatures above 3000 F.

New Method for Spalling Resistance of Porcelain Enamel

Committee C-22 on Porcelain Enamel has completed a method to determine the spalling resistance of porcelain enamel on aluminum. This method is based on immersion of coated panels in an ammonium chloride solution. There has been no authenticated case in which specimens have passed this test and then failed in service.

A method to determine the thermal stress and strain produced by porcelain enamel in metal substrates is under development. An enameled strip of steel acts like a bimetallic thermostat, and a differential transformer is used to measure the specimen deflection. In this manner, the stress behavior of various combinations of enamel coatings and base metals can be determined. This method may also be used to study the differential thermal expansion behavior of dissimilar metals bonded together by ceramic adhesives.

Interlaboratory work is continuing on the method of determining the coefficient of expansion of porcelain enamel. Also being investigated are methods for impact, continuity of coating by high- and low-voltage breakdown tests, and the sag characteristics of steel during firing of porcelain enamel coating.

Tests for Tape and Cement for Dry-Wall Joints

Test methods for joint tape and cement for gypsum wallboard construction will be recommended to the Society by Committee C-11 on Gypsum. These methods have a considerable body of research behind them.

Methods of Testing Gypsum and Gypsum Products (C 26) are now divided into three separate standards on: chemical analysis of gypsum and gypsum products; physical testing of gypsum plasters and gypsum concrete; and physical testing of gypsum board products and gypsum partitions, tile, and block.

The committee is considering a proposal requiring that the paper surfacing of gypsum wallboard shall have a maximum flame spread of 15 when tested in accordance with the Method of Test for Surface Burning Characteristics of Building Materials (E 84).

Begin Work on Standards for Agricultural Lime

Work on standards for agricultural liming materials, both lime and limestone, was begun by Committee C-7 on Lime. The new subcommittee will consult with various soil agronomy groups throughout the country.

A progress report was presented on the cooperative test program on fly ash and natural pozzolans. This program is based on a study of the physical characteristics of the materials, with combinations of plastic and nonplastic mixes being used. It is expected that this work will lead to revisions in the existing specification for fly ash for use as a pozzolanic material with lime (C 379).

Four methods of analysis for the determination of iron in lime are being studied in a round-robin test program. An additional program is planned for a further study of plasticity.

Some concern was expressed over the requirements included in the latest Federal Interim Specification for Hydrated Lime and in the lack of opportunity for many of the members of the committee to present comments. The committee will attempt to present its comments to the General Services Administration.

Mortar Field Tests Needed?

The need for field tests of mortars is being given attention in Committee C-12 on Mortars for Unit Masonry in response to requests from a number of consumer interests.

The research subcommittee is interested in the effect of longer wait in mixing mortars and in soundness tests on mortars composed of commercial masonry sands for different cementitious materials. A new specification for mortar and grout for reinforced masonry was accepted. This specification includes two types: type PM, consisting of portland cement, masonry cement and aggregate; and type PL, consisting of portland cement, hydrated lime, and aggregate.

International Standard on Graphite Microstructure

Recommended Practice for Evaluating the Microstructure of Graphite in Gray Iron (A 247) will be used as the basis for developing an international standard on the classification of graphite in the microstructure of iron. Committee A-3 on Cast Iron also reports that a paper on graphite classification for the new nodular (ductile) irons has been prepared for publication.

Two surveys of industry are in progress. One is on the satisfaction with current nodular iron specifications, and another is on the use of the various gray iron specifications. Interest in higher-efficiency internal combustion engines for highway, railroad, and stationary power units is resulting in demand for new design data on elevated-temperature thermal fatigue properties of iron.

Use of Malleable Iron at High Temperatures

Committee A-7 on Malleable Iron Castings will add to Specification A 47 on Malleable Iron Castings an appendix that will provide a basis for elevated-temperature use of standard malleable iron. Material for the appendix is based on work reported earlier to ASTM by Marshall and Sommer.[1]

A similar appendix will be added to Specification A 220 to provide for use of pearlitic malleable iron castings at elevated temperatures.

Chairman Gordon B. Mannweiler of Subcommittee VII on Corrosion presented a very complete progress report on the results of 1-yr atmospheric exposure tests of cast plates of standard malleable iron, pearlitic malleable iron, pearlitic ductile iron, and ferritic ductile iron; also rolled plates of SAE 1020, copper-bearing, and Corten steel. Included were specimens from two marine sites, two industrial sites, and one rural site. This test will continue, with removals at the end of 3, 7, and 12 yr.

Recommend Publication of Cass and Corrodkote Tests

The presence of copper ions (as well as ferric ions) in the atmosphere are known to be important accelerators in the corrosion of nickel coatings. In view of this the American Electroplaters Society established a research program to develop a copper-accelerated, acetic-acid salt-spray test for electrodeposited coatings (the Cass test). This test and the clay-pack high-humidity test (Corrodkote test) are being proposed for publication as tentative methods by Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys. The Corrodkote test has more variables than the Cass test owing to hand application of the clay slurry, but considerable experience shows that these tests do correlate well.

Apparatus to measure continuously the temperature and time-of-wetness of a specimen on exposure, and devices for continuously recording the sulfur dioxide content of the atmosphere have been installed at ASTM exposure sites at Kure Beach, N. C., South Bend, Pa., Cleveland, Ohio, Ottawa, Ont.,

[1] L. C. Marshall and G. F. Sommer, "Stress-Rupture Properties of Malleable Iron at Elevated Temperatures," *Proceedings*, Am. Soc. Testing Mats., Vol. 58, p. 733 (1958).

and Trail B. C. Specimens of copper, steel, and zinc are being exposed over one-month intervals at these sites to obtain comparative corrosion data.

Electroplating Definitions Ready for Publication

Committee B-8 on Electrodeposited Metallic Coatings and Related Finishes has prepared for publication a series of over 200 definitions relating to electroplating metals. These are the first definitions that have been prepared by the committee covering terms used in Society standards and in the industry.

A specification for multi-layer (duplex) electrodeposited nickel coatings has been prepared to permit standardization of these coatings for use in outdoor surfaces. Two systems are being considered for designating chromium-nickel-copper decorative coatings that will permit labeling to ensure consumer quality. One of these methods will be presented to the Society for publication at the earliest possible time.

Interlaboratory work is continuing to find the best dye for checking the sealing of anodic coatings on aluminum alloys. A specification for anodic film thickness has been completed.

Interlaboratory data on the use of magnetic flux gages to measure electrodeposited film thickness have been reported. These data will provide a basis for revising and enlarging existing thickness test methods in the near future.

Specimens for a program on decorative coatings for zinc-base die castings are being prepared. Exposure is expected by mid-1961.

The committee will sponser a symposium on electroforming in the near future. Those interested in participating on this symposium are urged to get in touch with Edward B. Saubestre, technical director, Enthone, Inc., Box 1900, New Haven 8, Conn.

New Exposure Program for Coated Wire

An atmospheric corrosion research program covering 65 types of aluminum and zinc-coated wire and wire products has been approved by Committee A-5 on Corrosion of Iron and Steel. Specimens will be exposed at seven sites in the summer of 1961.

Two new specifications have been prepared for presentation to the Society, for zinc-coated flat steel armor tape, and for copper-covered steel wire strand. A tolerance limit for the size of mesh in chain length fencing (A 392) is being considered.

A report covering the 1960 inspections of aluminum- and zinc-coated hardware exposed in 1958 has been completed and will be published with the 1961 Annual Report of the committee.

ASTM MEETINGS

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
April 5–7	Symposium on Materials and Electron Device Processing (Sponsored by Committee F-1)	Philadelphia, Pa. (Benj. Franklin)
April 10	Washington District (Joint with Raleigh Engineers' Club)	Raleigh, N. C.
April 10–12	Committee D-15 on Engine Antifreezes	Washington, D. C. (Shoreham)
April 10–12	Committee D-10 on Shipping Containers	Chicago, Ill.
April 11	Chicago District	Chicago, Ill.
April 18 (Tentative)	Northwest District (Joint with Am. Soc. of Mechanical Engineers and Am. Soc. for Metals)	Richland, Wash.
April 18	Committee E-1 on Methods of Testing	Philadelphia, Pa. (Society Headquarters)
April 19	New York District (Joint with New York Chapter of Am. Soc. of Civil Engineers)	New York, N. Y.
April 20	Western New York District	Buffalo, N. Y.
April 25	Detroit District	Detroit, Mich.
April 26	Pittsburgh District	Pittsburgh, Pa.
April 28	Washington District	Washington, D. C.
May 6	New England District	Orono, Maine (Univ. of Maine)
June 4–9	Committee E-14 on Mass Spectrometry	Chicago, Ill.
June 25–30	**Annual Meeting**	**Atlantic City, N. J. (Chalfonte-Haddon Hall)**
	1962	
Feb. 5–9	**Committee Week**	**Dallas, Tex. (Statler Hilton)**
June 24–29	**Annual Meeting**	**New York, N. Y. (Statler)**
Sept. 30–Oct. 5	**Pacific Area Meeting**	**Los Angeles, Calif. (Statler Hilton)**
	1963	
Feb. 4–8	**Committee Week**	**Montreal, Canada (Queen Elizabeth)**
June 23–28	**Annual Meeting**	**Atlantic City, N. J. (Chalfonte-Haddon Hall)**

Mowbray Named *MR&S* Editor

BEGINNING WITH THIS issue of *MR&S* the name of A. Q. Mowbray appears on the masthead as editor. This is a deserved recognition, since he has essentially been carrying out this function for some little time. He was largely responsible for the transition from the ASTM BULLETIN to the present *MR&S*, with increasing emphasis on the publication of technical material.

Mr. Mowbray took his B.S. in mechanical engineering at the University of Delaware in 1943, then spent 2½ years in the army. Discharged at the end of 1945, "a bomber pilot who never heard a shot fired in anger," he became shortly thereafter an instructor, then assistant professor of theoretical and applied mechanics at the University of Illinois, where he took his master's degree in 1949.

After several years with a technical publications firm in Quincy, Mass., Mr. Mowbray became an analytical engineer in the Vibration and Mechanical Metallurgy Section of Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn. His work at Hamilton Standard was primarily experimental stress analysis on propeller blades and other aircraft accessory hardware. He came to the ASTM Staff from Hamilton Standard in July, 1958.

It is hoped that this journal, one of the most important of the Society's publications, will continue to grow, under his direction, in character and significance and in service to our members.

MIT Awarded ASTM Doctoral Fellowship

Grants-in-aid go to The Pennsylvania State University, Queens College, Rutgers, Union College, and the University of Illinois.

THE MASSACHUSETTS INSTITUTE of Technology has been selected to receive the second ASTM Doctoral Fellowship established by the Board of Directors for the promotion of the knowledge of materials.

The fellowship provides for an award of $6500—$1500 for the Institute and $5000 for a student entering the final year of full-time graduate work on his doctor's degree in a field contributing to the science and the knowledge of materials. The fellowship will be administered and the recipient will be selected by MIT under its own rules and regulations governing fellowships.

Five Grants-in-aid Awarded

In addition to the fellowship, the Society also selected five schools to receive $1000 grants-in-aid to promote materials science through pure or applied research on materials. The grants, which are for the 1961–1962 school year, were made to:

The University of Illinois, Urbana, for work under Jo Dean Morrow on plastic deformation and fracture of crystalline materials, with particular attention to study of bubble nucleation as a means of delineating microscopic cracks, with possible application for direct observation of dislocations.

The Pennsylvania State University, University Park, to support the work being done under the direction of M. A. Wilkov on the investigation of the basic mechanisms that lead to fatigue failure in crystalline solids.

Queens College, Kingston, Ontario, Canada, to assist F. A. Hanes in research on the structure of the ferromagnetic copper - magnanese - gallium alloys.

Rutgers, The State University, New Brunswick, N. J., for work under J. H. Koenig in the field of high-frequency, ultra - low - dielectric - loss ceramic materials.

Union College, Schenectady, N. Y., for furthering research by H. E. Way on the growth of single crystals of zinc with known amounts of specific impurities and the analysis of physical properties of these crystals by use of the electron microscope and by X-ray diffraction.

The fellowships and grants-in-aid program was authorized by the Board of Directors in 1958 to provide a total of five annual $6500 fellowships and 25 $1000 grants-in-aid. The first awards were made very late in 1959. The first fellowship was granted to the University of Illinois, which selected R. E. Olson as the first ASTM Fellow (see ASTM BULLETIN, April, 1960).

The first five grants-in-aid were made to California Institute of Technology, Cornell University, the University of Minnesota, Northwestern University, and The William Marsh Rice University.

The California Institute of Technology applied its grant-in-aid to the purchase of a cathode-ray oscilloscope to further the research work being done by K. R. King and others concerned with research in materials (see ASTM BULLETIN, April, 1960).

The William Marsh Rice University awarded its grant to S. P. Victory, Jr., a graduate assistant and fellow in civil engineering, doing research related to the failure of a nonisotropic material subjected to triaxial stress (see *MR&S*, January, 1961).

The University of Minnesota awarded its grant to Leon Keer, who is studying for his Ph.D., to assist him in his research in the field of damping and fatigue properties of composite materials such as honeycomb sandwich configurations.

LEON KEER

Mr. Keer was born in Los Angeles, Calif., and attended public school there. He received his B.S. in mechanical engineering from the California Institute of Technology. While on a Howard Hughes Fellowship to Cal Tech, he obtained his M.S. in the physical metallurgy option of mechanical engineering in 1958. He then continued working at Hughes Aircraft Co. in an Environmental Analysis Group, his main interest being in reliability research in acoustic and random-vibration environments. Mr. Keer is an associate member of The American Society of Mechanical Engineers, a member of the Acoustical Society of America, and is a registered professional engineer in California and Minnesota. In 1959 he left Hughes to join the Department of Aeronautical Engineering, University of Minnesota, as a research fellow and to start a program of study leading to a Ph.D. in the mechanics of materials area. His major fields are applied mechanics, elasticity, vibration theory, dynamics, and plasticity, and his minor field is mathematics.

J. B. COHEN

Northwestern University awarded its grant to J. B. Cohen, assistant professor, Department of Metallurgy and Materials Science, to assist in the purchase of an X-ray diffractometer to further the research of graduate students in the Department of Materials Science on research topics concerned with X-ray diffraction. The students' principal concern in this area is in the examination of defects produced in metals and alloys under a variety of conditions.

Dr. Cohen received his B.S. and Sc.D. degrees in metallurgy from MIT in 1954 and 1957, respectively. After a year in Paris working in the field of X-ray diffraction with Prof. A. Guinier, he was employed for 14 months by the AVCO Corp., working in the field of materials engineering. He was particularly involved in work in ceramics and in beryllium-alloy and joining programs. After a six-month tour of duty with the U. S. Army in the Ballistic Research Laboratories, Aberdeen Proving Grounds, working on diffraction studies

of explosive loading, he joined the staff of Northwestern University.

Cornell University has awarded its grant to Prof. A. L. Ruoff to provide equipment that will enable him to extend his research on high-pressure effects on creep. Professor Ruoff's work will lead to more accurate descriptions of the nature of point defects in solids and will help to clarify the mechanism of creep. By measuring the time to obtain a given strain for different stress levels it is possible to obtain knowledge about the diffusion coefficient and hence the basic creep mechanism.

A. L. RUOFF.

Professor Ruoff obtained his undergraduate training at Purdue University and received the Bachelor of Science degree in 1952. He then went to the University of Utah for graduate work, where he studied physical chemistry under the direction of Dean H. Eyring. He received his Ph.D. degree in 1955 and joined the staff of the Department of Engineering Mechanics and Materials at Cornell University. He is presently an associate professor with teaching responsibilities in the field of materials at both the undergraduate and graduate levels. In addition to his teaching duties, he is carrying on an active research program.

Society Deficit for 1960 Much Smaller than Budgeted

Balanced Budget for 1961 Predicted

THE FINANCIAL OPERATIONS of the Society have resulted in a much better picture for 1960 than was anticipated at the beginning of the year. In the February, 1960, ASTM BULLETIN, we reported a budgeted operating loss in the neighborhood of $71,000. An examination of the financial statement at the end of the year revealed that the Society ended the year with an actual operating loss of only $7200. This included the placing of $100,000 in reserve for the 1961 Book of ASTM Standards instead of the $90,000 budgeted.

Several factors contributed to the improvement of the financial picture. A heavy sale of the 1959 Supplements, STP's, and miscellaneous publications more than offset lesser income from sales of the 1958 Book of ASTM Standards. Income from publications sales exceeded the budget by some $63,000. Also, additional income from the increase in the Annual Meeting registration fee was not anticipated at the time the budget was prepared. The favorable picture also was influenced by the publication and sale of some miscellaneous publications which had not been anticipated. These resulted in heavier expenditures than originally budgeted for special and miscellaneous publications, which were substantially offset by increases in receipts for the same items. Income from the sale of these will continue into this year.

For 1961, the Board of Directors, on the recommendation of the Finance Committee, has adopted a budget anticipating a modest margin of receipts over expenses amounting to about $1300. Those who follow the Society's financial operations will recall that the Society operates financially on a three-year cycle with a substantial margin of operating income over expenditures in the year following the appearance of the Book of ASTM Standards, followed by two years in which the picture is less favorable, often resulting in modest to substantial deficits. 1961 is normally such a deficit year, but since much of the expense of the 1961 Book of Standards is not actually incurred until 1962, the budget has been prepared accordingly, leaving a balance of $200,000 on the cost of the Book of Standards to be paid out of 1962 receipts.

OPERATING INCOME

	1957		1958		1959		1960	
		Per Cent		Per Cent		Per Cent		Per Cent
Dues and Entrance Fees	$ 283 389	27.7	$ 297 802	27.5	$ 373 583	25.9	$ 385 058	27.2
Sales of Publications	623 936	61.2	657 019	60.6	964 793	66.6	873 102	61.8
Miscellaneous								
Advertising	54 326	5.3	52 512	4.8	47 572	3.3	54 466	3.8
Interest and Dividends	30 492	3.0	31 097	2.9	29 099	2.0	28 675	2.0
Registration Fees	16 404	1.6	16 495	1.5	18 490	1.3	35 315	2.5
Exhibit	2 950	0.3	20 245	1.9	11 840	0.8	17 526	1.2
Other	9 183	0.9	8 846	0.8	3 606	0.2	18 755	1.3
Total Miscellaneous	113 355	11.1	129 195	11.9	110 607	7.6	154 737	11.0
TOTAL INCOME	$1 020 680	100.0	$1 084 016	100.0	$1 448 983	100.0	$1 412 897	100.0

OPERATING EXPENSE

	1957		1958		1959		1960	
		Per Cent		Per Cent		Per Cent		Per Cent
Publications	$ 430 175	41.9	$ 577 036	40.5	$ 616 589	44.8	$ 628 229	44.3
Salaries	360 171	35.2	406 126	35.8	431 444	31.4	459 522	32.4
General Office Expense	93 079	9.1	104 064	9.2	125 384	9.1	138 428	9.7
Meetings and Technical Committees	29 054	2.7	48 963	4.3	53 560	3.9	32 455	2.3
Headquarters Occupancy	41 089	4.0	40 144	3.5	55 060	4.0	61 502	4.3
Retirement, Social Security	49 672	4.8	48 392	4.3	62 830	4.6	67 020	4.7
Miscellaneous	24 922	2.3	27 687	2.4	30 184	2.2	32 960	2.3
TOTAL EXPENSE	$1 028 162	100.0	$1 252 412	100.0	$1 375 051	100.0	$1 420 116	100.0

1960 Receipts

From the accompanying tables it will be noted that dues and entrance fees accounted for $385,000, or 27.2 per cent of the total. Publications sales reached slightly over $873,000, about 61.8 per cent. Miscellaneous income amounted to almost $155,000, or 11 per cent.

1960 Disbursements

Disbursements for publications in 1960 amounted to $628,229, or 44.3 per cent, including $214,500 placed in reserve for publications obligated for in 1960, and for equalizing the cost of the Book of Standards over a three-year period. Salary expenditures were about $459,500, or 38 per cent, general office expenses, including provision for depreciation and amortization of the loan on the Cherry Street property, were about $138,500. Percentages of other costs are shown in the table.

1961 Budget

The 1961 budget is expected to be balanced. Receipts should total almost $1,500,000, with 63 per cent coming from sale of publications. On the operating expense side, publications may also be expected to account for the largest share of expenditures, $581,500, or about 39 per cent. Salaries, which include provision for additional members of the staff to handle increased publications load and administrative responsibilities, will amount to about $544,000, or 36.5 per cent. Adding to this general office expense, technical committee expenses, meetings, headquarters occupancy expense, retirement, insurance, social security, and miscellaneous, we reach a total of about $1,489,000 which, when the exact figures are compared, provides for a net operating gain of $1325, essentially a balanced budget. It is quite possible that operations during 1961 will increase this figure, since many of the items on the receipt side have been estimated conservatively and on the disbursements side liberally. Perhaps the most uncertain figure is the income to be expected from the additional parts of the Book of ASTM Standards which members choose to receive on their membership at $6 per part. The increase from $3 to $6 has caused a number of members to review their orders, and a decrease in the number of parts distributed in this way may be expected. Whether or not the decrease is greater or less than that estimated will tell the story as to whether or not the Society will end the year in the black or in the red.

ESTIMATED BUDGET SUMMARY
1961
(Dec. 1, 1960–Nov. 30, 1961)

Operating Income	1961 Budget	Per Cent
Dues and Entrance Fees	$ 393 675	26.4
Publications	943 500	63.0
Miscellaneous	153 300	10.3
TOTAL OPERATING INCOME	$1 490 475	100.0
Operating Expense		
Publications	$ 581 500	39.0
Salaries	543 700	36.5
General Office Expenses	151 500	10.2
Technical Committee Expenses	13 000	0.9
Meetings	26 750	1.7
Headquarters Occupancy Expenses	61 900	4.2
Retirement, Insurance, Health Expense	72 300	4.9
Miscellaneous Expenses	38 500	2.6
TOTAL OPERATING EXPENSE	$1 489 150	100.0
NET OPERATING GAIN	1 325	

TECHNICAL COMMITTEE NOTES

Magnetic Properties of Iron-Aluminum Alloys

WITH THE INCREASING use of aluminum as an alloying element in steel, Committee A-6 on Magnetic Properties is faced with the problem of revising its standards for magnetic testing of these materials to take into consideration the lower densities of iron-aluminum alloys. In the April, 1960, ASTM BULLETIN, a density table for iron-aluminum alloys with aluminum content from 0 to 16 per cent, in steps of 2 per cent, was given. There is some question whether intervals of 2 per cent are too great for satisfactory interpolation. Density is one property that must be known accurately for calculation of cross-sectional area of magnetic specimens to be tested.

A matter of considerable current interest to the committee is the precision and accuracy of magnetic testing methods. Since these methods are used in grading materials to set price, in quality control, and in research, the level of precision to be expected of them must be known. In published standards for magnetic testing, the tolerances for the various instruments used are given. The over-all error of the method can be considerable if all the tolerances are additive. The committee is endeavoring to determine this maximum possible error, and it is also attempting to estimate the expected level of precision, using the best available instruments.

Extensive revisions in the definitions of terms relating to magnetic materials (A 340) will be submitted to the Society in the near future.

The above actions occurred at meetings of the committee and its subcommittees and task groups on January 16 and 17 at the Penn-Sheraton Hotel in Pittsburgh.

New SBR Rubbers Announced

NUMBERS 1024 and 1511 have been assigned to two new low-viscosity styrene-butadiene rubbers (SBR) recently brought on the market. Assignment was made by ASTM Committee D-11 on Rubber and Rubber-Like Materials through its Subcommittee XIII on Synthetic Elastomers, B. S. Garvey, chairman, in accordance with the Tentative Recommended Practice for Description of Styrene-Butadiene Rubbers (SBR) and Butadiene Rubbers (BR) (D 1419–60a T).

DESCRIPTIONS OF NEW SBR RUBBERS.

Number assigned	1511	1024
Date assigned	1/9/61	1/13/61
Requested by	Goodrich-Gulf Chemicals Inc.	Phillips Chemical Co.
Distinctive feature	Low Mooney viscosity	Low Mooney, ND shortstop
Close previous number, if any	1508, 1510	1010; was Phillips 6701
Type	1500	1000
Nominal temperature, deg Fahr	43	122
Activator	FRA	...
Shortstop	ND	ND
Antioxidant	NST	NST
Catalyst	OHP	P
Emulsifier	FA	FA
Nominal bound styrene, per cent	23.5	25
Nominal conversion, per cent	60	68
Nominal Mooney viscosity, ML 1 + 4 (212 F), polymer	40	30
Nominal Mooney viscosity, ML 1 + 4 (212 F), compound	70	35
Coagulation	SA	Alum
Carbon black:		
Type	...	...
PHR	...	...
Oil:		
Type	...	...
PHR	...	...
Finishing	Normal	Normal

NOTE.—Abbreviations and symbols are defined as follows: FRA = free radical type, that is, iron pyrophosphate, peroxamine sulfoxylate. ND = nondiscoloring. NST = nonstaining. OHP = organic hydroperoxide. FA = fatty acid. SA = salt acid. P = persulfate.

Lumber Grading Methods Under Scrutiny

FOR MORE than a 25 years, ASTM Methods D 245 have been universally recognized and used by the various lumber associations as a basis for the establishment of structural grades of lumber. A new method is now under discussion in Committee D-7 on Wood to provide procedures for evaluating the useful strength of any grade of dimension lumber, including what is commonly known as "yard" lumber. The increased use of light wood trusses and framing in building construction makes it increasingly desirable to evaluate the strength of the assembly rather than the individual piece. At the meeting of the committee held at the Forest Products Laboratory, Madison Wis., on January 19 and 20, task groups were authorized to draft a proposed tentative method.

Another material receiving considerable attention is wood-base fiber and particle panels. Under consideration is a new type of ½-in. nail-base sheathing which is a high-density structural insulating fiber board designed for use in wood frame construction to permit the direct attachment of exterior siding materials such as wood and asbestos-cement shingles. Structural fiber board insulating roof deck for use in residential construction is also under study.

Moisture content in lumber is an important factor in its strength. Proper moisture control requires a rapid and reliable means of inspecting lumber for moisture content. Several procedures for determining moisture content are under consideration, including the oven drying, electrical moisture meter, and distillation methods. The electric moisture meter is considered one of the best means of controlling moisture in the field.

With the completion of the extensive wood pole research program, attention will now be given to the need for test methods for cross arms. The subject of wood poles is still of interest, however, in view of the considerable increase in the use of wood poles in building construction. Poles for this use require a different type of test from poles used in electric transmission lines. A task group will be organized to study this subject.

The committee heard a report on the latest research findings on the structure of wood using the electron microscope, presented by Irving Sachs, U. S. Forest Products Laboratory. An illustrated talk on the Los Angeles School Fire Tests was presented by T. K. May, West Coast Lumbermen's Assn.

A dinner meeting was held by the committee for all ASTM members in the Madison area. An interesting talk was given by Prof. P. G. Fox of the University of Wisconsin on the subject "Gamblers Don't Gamble." Professor Fox has a reputation as an analyst of games of chance, particularly those practiced in Las Vegas and Reno. His scientific approach was quite enlightening.

Gas Chromatography Committee Born in Snow Storm

Some hundred persons felt it was so important for the Society to organize a committee on gas chromatography that they traveled across country in some of the worst weather in decades to the organization meeting held in Philadelphia on February 6. The need for standards for this very useful analytical technique was very evident from discussions at the meeting, and hopes are high that the new committee may help to bring some order out of a chaotic situation. At the meeting, the following title, scope, and subcommittee organization were approved:

Title: Committee E-19 on Gas Chromatography.

Scope: To promote the development and application of gas chromatography by:

a. Coordinating scientific applications and methods of analysis based on gas chromatography in cooperation with other technical committees of the Society and other organizations.

b. Cooperating with national and international bodies in standardizing (1) presentation of data and (2) nomenclature.

c. Developing general methods and other appropriate standards.

d. Providing a forum for exchange of information.

e. Stimulating research in this field.

f. Collecting and disseminating critical data.

Subcommittees:

I. Nomenclature, Definitions, and Standard Data.
II. Programs and Papers.
III. Research.
IV. Coordination and Standardization of Methods.

The following officers were elected:

Chairman, B. F. Dudenbostel, Jr., Esso Research and Engineering Co.
Vice-Chairman, C. H. Orr, Procter & Gamble Co.
Secretary, C. G. Harriz, Houdry Process Corp.

It was evident at the meeting that much effective spade work had been done by the steering committee, consisting of F. H. Stross, chairman, Shell Development Co., J. F. Hickerson, Humble Oil Refining Co.; C. H. Orr, Procter & Gamble Co.; E. G. Wiest, E. I. du Pont de Nemours & Co.; and M. K. Testerman, University of Arkansas. Mr. Hickerson presided at the meeting.

The committee will have its first full-scale meeting for organization of subcommittees in Chicago early in June, in conjunction with meetings of Committee E-14 on Mass Spectrometry.

This is the fifth committee in the Society to be organized around an analytical technique, in this case gas chromatography. The others are E-2 on Emission Spectroscopy, E-13 on Absorption Spectroscopy, E-14 on Mass Spectrometry, and the Joint Committee on Chemical Analysis by Powder Diffraction Methods.

NEW ASTM PUBLICATIONS

Symposium on Acoustical Fatigue

STP 284, 60 pages, price $2.50, to members $2.00.

ACOUSTICAL FATIGUE is a child of the jet and rocket age. Noise levels produced by the powerful blast of a jet exhaust are high enough to excite damaging vibrations in the airframe structure. It is estimated that about 1 per cent of the energy in the fuel of a large jet engine is converted into sound—this means that sound energy is generated at the rate of about 50,000 watts. Furthermore, this noise covers a random, broad frequency spectrum that includes most of the important modes of vibration of airframe structures. At some of these frequencies, millions of stress cycles can be accumulated in a matter of hours.

Many problems are posed by this phenomenon—some old, mostly new: (1) how to predict or measure the noise spectrum to which a structure is exposed, (2) how to determine the stresses and vibration modes produced by that noise, (3) how to predict the fatigue life under such random loading, (4) how to verify that prediction, and (5) how to design for increased fatigue life. This symposium volume presents the latest thinking on these questions by those in the forefront of the battle against acoustical fatigue. The contents:

Material Properties that Affect Acoustical Fatigue Life, and the Role of Damping—W. J. Trapp, Wright Aeronautical Development Div., and B. J. Lazan, University of Minnesota.

Prediction of Acoustic Fatigue Life—H. C.

Schjeldrup, National Engineering Science Co.

Fatigue of Structural Metals Under Random Loading—A. M. Freudenthal, Columbia University.

The Fatigue Damaging Effect of a Random Load—Waloddi Weibull, Bockamöllan, Sweden.

Experimental Techniques and Equipment for Acoustical Fatigue Research and Development—D. M. Forney, Jr., Wright Aeronautical Development Div.

Reinforced Plastics for Rockets and Aircraft

STP 279, 140 pages, hard cover, price $5.50, to members $4.40.

REINFORCED PLASTICS are to rockets and aircraft what reinforced concrete is to heavy construction. Not only do reinforced plastics have a high strength-to-weight ratio, but they also have high ablation resistance. This combination of properties makes reinforced plastics useful for rocket nose cones, which are subject to heating on re-entry into the atmosphere, and also for rocket nozzles, where the gases leave at high temperature and high velocity.

The reinforced plastics discussed in this publication are composite materials with either continuous-wound fibrous-glass roving, or multiple plies of glass textiles, either of woven yarns or chopped fiber mat, the binder being an organic polymer or resin of any of several types —phenolic, polyester, epoxy, etc.

Because of the relative newness both of the material and the application, there have been and are some difficult problems of design, fabrication, quality control, and testing. It was to lay a base line for what is now known about these problems that the two symposia were held in San Francisco in October, 1959, on the related subjects, "Reinforced Plastics" and "Thermal Ablation." These two symposia combined in this book provide a valuable reference for all those working in the exciting new field of rocketry as well as for those concerned with more down-to-earth applications of reinforced plastics.

The following papers are included in the volume:

Introduction—H. A. Perry, Naval Ordnance Laboratory.

Symposium on Reinforced Plastics

Evaluation of Reinforced Plastics for High-Temperature Structural Applications—V. F. Hribar and A. M. Dowell, Hughes Aircraft Co.

Evaluation of Reinforcements for Structural Plastics—P. W. Erickson, V. Milani, I. Silver, and H. A. Perry, Naval Ordnance Laboratory.

Permeability of Materials Under High Pressures and at Various Temperatures—George Epstein and W. W. Gary, Jr., Aerojet-General Corp.

Symposium on Thermal Ablation

Principles and Capabilities of Ablation—Wolfgang H. Steurer, Convair.

Testing of Materials Under Ablative Conditions—Harry A. King, Aerojet-General Corp.

Photographic Technique of Surface Temperature Measurement—James H. Siviter, Jr., National Aeronautics and Space Administration.

Testing of Reinforced Plastics Under Simulated Re-entry Conditions—R. R. John and W. L. Bade, AVCO Research and Advanced Development.

Arc Jet Measurements Related to Ablation Test Validity—Rolf D. Buhler and Daphne Christensen, Plasmadyne Corp.

Shear and Torsion Testing

IN PAST YEARS considerable effort has been spent by certain ASTM product committees in developing standard shear test methods for adhesives, elastomeric vulcanizates, plastics, plywood, wood, rubber cements, soil, and road surfacing materials. However, little standardization between shear methods on various materials has been accomplished. Considerable work in the metals field has led to the development of several shear test methods, but none seems to have gained universal acceptance.

Subcommittee 25 on Shear and Torsion Tests of ASTM Committee E-1 on Methods of Testing sponsored this symposium at the 1960 Annual Meeting of the Society. The intention was to provide a comprehensive review of shear and torsion test methods and to develop information that would be useful to the subcommittee in establishing tentative recommended shear and torsion test practices.

The contents are:

Introduction—Raymond W. Fenn, Jr., The Dow Metal Products Co.

Maximum Shear Strain Measurements and Determination of Initial Yielding by the Use of the Photoelastic Coating Technique—Felix Zandman, Budd Co.

Stress Distribution in Single-Shear Sheet Specimens—C. S. Yen, Douglas Airplane Co.

Design and Development of Tensile-Loaded Shear Specimen—E. J. Zapel, Boeing Airplane Co.

Load Transfer in Spot Welds: A Preliminary Investigation with Photoelastic Coating—Norman A. Freytag, The Budd Co.

Bonded Metal-to-Metal Shear Testing—Lee R. Lunsford, Convair.

On the Lap-Joint Shear Test for Metal-to-Metal Bonds—R. S. Shane, General Electric Co.

Preparation of Metal Surfaces for Adhesive Bonding—R. S. Shane, General Electric Co.

Shear and Torsion Testing of Wood, Plywood, and Sandwich Constructions at the U. S. Forest Products Laboratory—W. G. Youngquist and E. W. Kuenzi, U. S. Forest Products Laboratory.

Photoelastic Evaluation of the Panel Shear Test for Plywood—Eugene L. Bryan, Forest Products Laboratory.

A Dynamic Test for Determining Shear Modulus of Sandwich Core Materials—M. E. Raville, W. B. Bickford, and D. A. Huber, Kansas State University.

A Technique for Torsional Testing of Refractory Materials at Temperatures Up to 2800 C—C. E. Waller and M. L. Stehsel, Aerojet-General Corp.

Shear and Torsion Testing of Solid Materials: A Critical Discussion—R. B. Clapper, Lockheed Missiles and Space Div., Lockheed Aircraft Corp.

STP 289, 128 pages, hard cover, price $4.75, to members $3.80.

Low-Temperature Properties of High-Strength Aircraft and Missile Materials

STP 287, 232 pages, hard cover, price $7.00, to members $5.60.

OWING TO the increasing use of cryogenic propellants such as liquid oxygen and liquid hydrogen in missiles and space vehicles, the properties of high-strength structural materials at extremely low temperatures are becoming of prime importance. Until relatively recently, liquefied gases were produced primarily for commercial applications, and these low-temperature liquids could be adequately held and carried in tanks and piping made from low-strength materials. However, with the recent advent of high-speed, rocket-propelled aircraft and of large, cryogenic-fueled missiles, it has become necessary to use materials having the highest possible strength-to-weight ratios in order to meet design and performance requirements.

Since this symposium was aimed at missile and space-vehicle applications, attention is focused on the mechanical properties of high-strength sheet alloys at temperatures ranging down to −423 F. Aluminum, magnesium, titanium, and stainless steel alloys are studied. To be suitable for space vehicles these materials must demonstrate high strength-to-density ratios, good toughness, adequate weldability, corrosion resistance, and good formability. How certain alloys meet these demands is carefully documented in the 14 papers comprising this symposium volume.

This volume attempts to present an over-all picture of the present state of knowledge concerning the cryogenic properties of high-strength materials. The hope is that it will also encourage further study in certain areas where design data are still lacking. The contents of this publication are:

Introduction—J. F. Watson, Convair-Astronautics.

Sharp-Notch Behavior of Some High-Strength Sheet Aluminum Alloys and Welded Joints at 75, −320, and −423 F—M. P. Hanson, H. T. Richards, National Aeronautics and Space Administration, and G. W. Stickley, Alcoa Research Laboratories.

Some Low-Temperature Properties of Aluminum Alloy Weldments—W. R. Lucas and C. E. Cataldo, Army Ballistic Missile Agency.

Thermal Cycling Under Constant Load to Low Temperatures of Aluminum and Magnesium Alloys—V. Weiss, G. T. Schaeffer, A. Saule, and G. Sachs, Syracuse University Research Inst.

Low-Temperature Properties of Cast and Wrought Magnesium Alloys—R. W. Fenn, Jr., Dow Metal Products Co.

Some Mechanical Properties of Magnesium Alloys at Low Temperatures—R. P. Reed, R. P. Mikesell, and R. L. Greeson, National Bureau of Standards.

Sharp-Edge-Notch Tensile Characteristics of Several High-Strength Titanium Sheet Alloys at Room and Cryogenic Temperatures—G. B. Espey, M. H. Jones, and W. F. Brown, Jr., National Aeronautics and Space Administration.

Materials for Use at Liquid-Hydrogen Temperature—J. H. Belton, L. L. Godby, and B. L. Taft, Pratt and Whitney Aircraft.

Effect of Stress Concentration on Tensile Strength of Titanium and Steel Alloy Sheet at Various Temperatures—G. Sachs and J. G. Sessler, Syracuse University Research Inst.

Mechanical Properties of High-Strength 301 Stainless Steel Sheet at 70, −320, and −423 F in the Base Metal and Welded Joint Configuration—J. F. Watson and J. L. Christian, Convair-Astronautics.

Effect of Rerolling on Properties of Modified Type 347 Stainless Steel—C. R. Mayne, International Nickel Co., Inc.

Properties of Some Precipitation-Hardening Stainless Steels and Low-Alloy High-Strength Steels at Very Low Temperatures—J. C. Campbell and L. P. Rice, Battelle Memorial Inst.

Low-Temperature Properties of Cold-Rolled AISI Types 301, 302, 304ELC, and 310 Stainless Steel Sheet—J. F. Watson and J. L. Christian, Convair-Astronautics.

Effect of Carbon Content on the Notch Properties of 43XX-Vanadium Modified and 5 per cent Chromium Sheet Steels—E. P. Klier, Catholic University of America.

Summary—A. Hurlich, Convair-Astronautics.

Properties of Crystalline Solids

THIS PUBLICATION represents the first public effort of the Society's Division of Materials Sciences in sponsoring two broad-subject symposia at the 63rd Annual Meeting of the Society in June, 1960. Papers from the two sessions, entitled "Recent Progress in Materials Sciences" and "Nature and Origin of Strength of Materials," are published together under the title "Properties of Crystalline Solids."

In his introductory paper, W. O. Baker, vice-president of research, Bell Telephone Laboratories, placed in perspective the Society's role in materials sciences as a part of its longstanding function of promoting materials knowledge. According to Dr. Baker:

"All during these heroic times of science and technology, the studying and the using, inventing, and testing of materials went on, but they were hardly considered to be domains suitable for detached thought and for the application of bold hypotheses and brilliant theory. In recent decades this situation has changed dramatically. The names who helped to change it have been mentioned in the papers of today's symposia. It is an historic event in the evolution of science and technology to hold symposia like these, with speakers of such vision. This, along with the establishment of the Division of Materials Sciences of ASTM, signifies that bulk properties of matter do challenge the deepest understanding as well as the best exploitation. We have been excited to see the nucleation and growth of the new Division, an epitaxial growth on the firm base of Professor Woods and his Steering Committee, and particularly the undislocated, nonvacant lattice points of co-chairmen J. H. Koenig and I. V. Williams, A. A. Bates and J. D. Sullivan."

Continuing, Dr. Baker emphasized the dimensions of the new domain that is being established by the joining of materials technology, in which ASTM has been so vital a force, and the science of solids constituted of the physics of crystals, mechanics, chemistry, metallurgy, and of many diverse resources of mathematics, statistics, electronics, and certainly of dialectics. Research and development of materials, he said, offer both the task and the chance for ventures of the mind as rewarding and as revealing as those of the great epics of physical science—the wave-particle duality of radiation and electronics, the composition and formation of the nucleus, the spectroscopy of the separate atom and the molecule, the chemistry of combination and structure.

The following papers are included in the publication:

The National Role of Materials Research and Development—W. O. Baker, Bell Telephone Laboratories, Inc.

Symposium on Recent Progress in Materials Sciences

Accomplishments and Limitations of Solid State Theory—Harvey Brooks, Harvard University

The Influence of Surfaces on the Properties of Materials—M. J. Sinnott, University of Michigan

Mechanical Properties of Semiconductors—J. N. Hobstetter, University of Pennsylvania

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Resistance to Creep Deformation and Fracture in Metals and Alloys—F. Garafalo, U. S. Steel Corp.

Brittle Fracture Strength of Metals—E. T. Wessel, Westinghouse Electric Corp.

Effects of Size and Shape on Fracture of Solids, G. R. Irwin, Naval Research Laboratories

Fatigue Strength of Crystalline Solids—G. M. Sinclair, University of Illinois

STP 283, 150 pages hard cover, price $4.00, to members $3.20.

Report on Available Standard Samples and Related Materials for Spectrochemical Analysis—1960

THIS REPORT provides a comprehensive listing of available standard samples, reference materials, and high-purity materials for use in spectrochemical analysis, as of September, 1960. Coverage includes 2145 spectrographic standards, 205 chemical standards, 864 high-purity materials, and 185 reference samples. Standard samples include metals, ceramic materials, steelmaking alloys, ores, refractories, oil additives, and others.

Complete names and addresses of all known suppliers of standard samples and high-purity materials are given in alphabetic lists.

STP 58-D, 116 pages, paper cover, price $3.75, to members $3.00.

Petroleum Products and Lubricants

ASTM Standards on Petroleum Products and Lubricants, Vol. II, 712 pages, hard cover, price $7.50, to members $6.00.

AS ANNOUNCED in the October, 1960, issue of the ASTM BULLETIN, the 1960 compilation of ASTM Standards on Petroleum Products and Lubricants, prepared by Committee D-2, is being offered in two volumes, the first of which was published in October. Volume II is now available.

This second volume of the 37th edition contains 168 standards and tentatives of interest to the petroleum industry but prepared by other ASTM technical committees. Of this number, 130 standards and tentatives have not previously been published in a D-2 compilation. The wide variety of subjects covered include the following:

Bituminous Materials for Roads, Paving, Roofing, and Waterproofing
Carbon Black
Gaseous Fuels
Industrial Aromatic Hydrocarbons
Paint, Varnish, and Lacquer
Wax Polishes
Quality Control
Spectroscopy
General Methods of Testing

Punched Cards for High-Temperature Strength Data on Metals and Alloys

Price $7.50 per group, to members $6.00 per group. Price includes code book.

OVER THE YEARS industry has looked to the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals for the compilation and dissemination of data on the high-temperature properties of metals. As a result, several Special Technical Publications have been issued to meet these demands.

However, in recent years, the need for high-temperature data has increased tremendously, and so has the generation of such data in the many high-temperature laboratories. Ideally, this information should be collected and compiled on a current and continuing basis. The "batch" process of collecting data at, say, five-year intervals is no longer adequate.

To furnish this service to industry on a current basis, the committee is now collecting the data and making it available on punched cards. These are 8 by 10½-in. McBee cards designed to carry a maximum of high-temperature data such as: chemical composition, heat treatment, microstructure, hardness, and short-time tensile, creep, and rupture strengths. The cards are coded for selective sorting by material, form, type of test, alloy, producer of the material, and the source of the data. A temperature code is not used because most of the cards will contain data at several temperatures.

Collecting the data and transferring it to punched and coded cards are fairly involved processes. Success of the program may depend heavily on grouping and distribution. The committee, accordingly, has adopted a simple arrangement allowing purchasers to select groups of cards on the basis of material. The cards are packaged and sold in sets of the following categories:

Group I.—Light alloys (aluminum, magnesium, titanium, copper, beryllium, lithium, and zirconium.

Group II.—Iron and steel including the AISI stainless steels.

Group III.—Superalloys, refractory alloys, and miscellaneous alloys.

The initial distribution consists of 25 cards in each of Groups II and III, plus a miscellaneous group that cuts across all three categories. The latter arrangement is offered this time only because the data had been collected across the board earlier in the development of the program and represented important contributions that should be distributed. A complete code book with sorting instructions will accompany each set of cards.

Copper and Copper Alloys

ASTM Standards on Copper and Copper Alloys, 760 pages, hard cover, price $9.25; to members $7.40.

THE 1960 EDITION of the compilation of ASTM Standards on Copper and Copper Alloys will contain the current 120 specifications and 20 test methods relating to this field of industry.

Added since the previous edition are specifications for: nickel-coated soft or annealed copper wire for electrical equipment. copper-nickel alloys in ingot, slab, or shot form; copper and copper-alloy seamless condenser and heat-exchanger tubes with integral fins, and hard-drawn copper capillary tube for restrictor applications. Revisions have been made in 27 specifications and 7 methods of test retained from the previous edition. As usual, a subject index is included.

MATERIALS SCIENCES

Report of Executive Committee Meeting

MANY LETTERS have been received at Headquarters expressing interest in active participation in the Division of Materials Sciences. Participation in the division is open to all members of the Society, but in order to focus the interests of those who would like to contribute more actively, a membership roster for the division will be established. The plan approved by the Executive Committee at its meeting during Committee Week in Cincinnati provides for membership in the division for all those members of the Society who indicate a desire to participate. The plan will go into effect after the Annual Meeting, assuming approval by the council.

It was proposed also by the Executive Committee to broaden the membership in the Division Council, keeping the control in the hands of representatives of technical committees by pro-

viding that members-at-large shall not exceed the total number of authorized committee representatives. This would enlarge the council beyond the present 100 maximum and provide for more participation by people actively interested in having a hand in the administration of the division.

Division Program for 1961

Major Effects of Minor Constitutents on Properties of Materials is the subject for a two-session symposium to be held Monday afternoon and evening, June 26, at the Annual Meeting. Five papers will be included in the two sessions, thus allowing ample opportunity for discussion. Unlike the Materials Sciences symposia at the 1960 Annual Meeting, at which all the papers dealt with crystalline solids, the paper in the upcoming symposium will cover organic liquids, polymers, plasmas, metals, and ceramics, the objective being to find some common ground for materials in quite different physical states. The emphasis will be on review and education, hoping for broad participation by technical people working in diverse fields. The discussion should set in motion new trains of thought for people who may have become accustomed to narrower frames of reference as specialists in particular materials fields.

The Division Council will meet Tuesday morning, June 27 to discuss the division's organizational plans mentioned above and extend the efforts of the Executive Committee in shaping the division's future policies and programs.

Future Symposium Plans

The Executive Committee is planning ahead into 1962 for Materials Sciences symposia. For the 1962 Annual Meeting, to be held in New York, the symposium subject will be stress-strain-time-temperature relationships for a variety of materials. For the September, 1962, Pacific Area meeting in Los Angeles, the symposium subject will be on properties of surfaces. The committee is also planning a special function for the Committee Week meeting in February, 1962, in Dallas.

Suggestions Invited

The Executive Committee is open to suggestions from readers of this column for activities that the division might undertake. Communications addressed to Headquarters will be forwarded to the officers of the committee. Officers and members of the Executive Committee are as follows:

K. B. Woods, chairman, Purdue University
R. T. Kropf, vice-chairman, Belding Heminway Co., Inc.
F. Y. Speight, secretary, ASTM Staff
A. A. Bates, Portland Cement Assn.
M. N. Clair, The Thompson & Lichtner Co., Inc.
W. L. Fink, Aluminum Company of America
F. L. LaQue, The International Nickel Co., Inc.
B. J. Lazan, University of Minnesota
J. D. Sullivan, Battelle Memorial Inst.
A. C. Webber, E. I. du Pont de Nemours & Co., Inc.
I. V. Williams, Bell Telephone Laboratories, Inc.

A Note from Chairman Woods

This is your column. Space will be made available for letters and comments expressing various points of view relating to Materials Sciences and the role of the Society as a medium for expression and dissemination. We should also like to receive your comments, pro and con, as to the content of the column to date.

DISTRICT ACTIVITIES

Bates and Marshall Go West

ASTM President A. Allan Bates and Executive Secretary Thomas A. Marshall, Jr., spent a week in January getting better acquainted with members of the three ASTM Districts along the West Coast.

At meetings of the Southern California, Northern California, and Northwest Districts, President Bates gave the principal address. In his talks, Dr. Bates discussed the democratic (small d) nature of ASTM philosophy, organization, and operation, the role of materials in the nation's future, and new and coming developments in the field of construction and construction materials. On each occasion Dr. Bates' comments generated lively discussion.

Mr. Marshall also spoke briefly to each group, introducing himself as the new man at the reins at Headquarters and expressing his confidence in a bright future for the Society. He also took the opportunity to comment on the new look in the ASTM BULLETIN.

The January 19 meeting of the Southern California District was held jointly with the Southern California Chapter of the American Concrete Inst. Dinner was at the Roger Young Auditorium in Los Angeles. ACI Chapter President Dewain R. Butler and ASTM District Council Chairman J. B. Howe introduced prominent members of their respective groups to the 175 persons present. Dr. Bates was introduced by Byron P. Weintz, ACI Chapter Vice-President.

The meeting of the Northern California District took place at the Engineers' Club in San Francisco on January 23. This meeting was joint with the Northern California Chapter of ACI. Among the 120 present were the two top national officers of ACI—J. W. Kelly, president, and Lewis Tuthill, vice-president. Prominent ACI members present were introduced by Harry E. Thomas, ACI Chapter President. ASTM notables present were introduced by G. J. Grieve, chairman of the ASTM Northern California District Council.

The meeting on January 25 at the Washington Athletic Club in Seattle was the first for the newly formed Northwest District, comprising British Columbia, Oregon, Idaho, and Washington. Provisional chairman of the new Council is Carl E. Minor, Washington State Highway Commission. Nominated at the meeting for the offices of chairman, vice-chairman, and secretary, respectively, were Mr. Minor, S. H. Graf, Oregon State College, and A. H. Rauch, U. S. Plywood Corp.

Other members of the provisional Northwest District Council are: R. L. Burke, Irrigation Equipment Co., Inc.; J. C. Cook, Washington Testing Laboratories; H. P. Ford, Eugene Concrete Pipe and Products Co.; C. C. Heritage, consulting engineer; W. B. Kirby, Electric Steel Foundry Co.; E. N. Klemgard, Washington State University; C. M. Kreider, Brooks-Scanlon, Inc.; D. W. McLenegan, Hanford Atomic Products Operation; H. L. Milligan, Boeing Airplane Co.; R. R. Socky, Hanford Laboratories; and H. W. Zeh, Reynolds Metals Co.

WASHINGTON

Blizzard Fails To Halt Meeting

A RAGING BLIZZARD that dropped nine inches of snow on Baltimore failed to cool the enthusiasm of 170 intrepid souls who braved the elements to hear ASTM President A. Allan Bates discuss "Technical Advances in the Soviet Union." Dr. Bates' talk capped a full day of district activities in the Baltimore area, Feb. 3.

Through the courtesy of the Bethlehem Steel Co., a tour of its Sparrows Point plant started at mid-morning. Two full bus loads of members and their guests were shown the cycle of steel manufacturing from ore to finished tinplate. While the storm raged outside, they watched the molten steel bubbling in open-hearth furnaces and

saw red-hot ingots roaring down the rolling mills. Inspection of the sheet and tin strip mills completed the tour. Arrangements for the tour were made by William D. Poole, chief metallurgist at the Sparrows Point plant.

Back at the headquarters hotel, those not wishing to take the tour had the opportunity to view a motion picture provided by the Maryland Port Authority depicting the growth of Maryland seaports and their current facilities.

Following a social hour, dinner was served in the ballroom of the Sheraton-Belvedere Hotel. Dr. Bates' talk followed.

In his slide-illustrated lecture, Dr. Bates pointed out that industrial growth in the Soviet Union would probably be of more concern to us than the doctrines of the Communist party. He stated that even now in the USSR changes have been made in recent years which to a certain extent have led away from the ideas of Marx and Lenin.

By use of his slides, Dr. Bates illustrated the wide use of precast and prefabricated concrete units in Soviet construction. Hundreds of standardized buildings are being built by this method. Extensive use is also being made of lightweight insulating aggregates, porous concrete, double waffle-slab panels, and concrete mixes incorporating various organic insulating materials. Dr. Bates' talk was received with enthusiasm and brought numerous questions from the floor.

Governor Tawes of Maryland, who could not be present at the meeting because of the inclement weather, was represented by J. L. Kronau, chairman of the Maryland Port Authority. Arrangements for the meeting were made under the direction of J. E. Wood, Maryland State Roads Commission, assisted by W. E. Dickinson, Calcium Chloride Inst., W. D. Poole, Bethlehem Steel Co., Inc., R. W. Seniff, Baltimore & Ohio Railroad Co., and L. W. Shuger, Baltimore Paint and Chemical Corp.

SOUTHWEST

Soviet Construction Methods

"To a far greater degree than many realize the Soviets are using precast concrete for construction." With this statement ASTM President A. Allan Bates, vice-president, Portland Cement Assn., opened his slide-illustrated lecture, "Observations on Construction Methods Being Used in the Soviet Union." He spoke before a joint meeting of the Southwest District of ASTM and the Austin Chapter of the American Society of Civil Engineers in Austin, Tex., February 24.

Drawing on his recent experiences as head of an information exchange group which toured the Soviet Union to study construction methods, Dr. Bates went on to describe in detail factories used to produce precast and prefabricated concrete building units, walls, roofs, and, in fact, entire apartments.

Cooperating in this first district meeting to be held in Austin were the San Antonio Chapter of ASCE as well as the Student Chapter of ASCE at the University of Texas. Arrangements for the meeting were made by Prof. R. F. Dawson, of the University of Texas.

SOUTHERN CALIFORNIA

Fatigue Session Held at Metal Congress

THE SOUTHERN CALIFORNIA District sponsored a half-day technical session on fatigue at the Western Metals Congress in Los Angeles, Calif., the week of March 20. Arrangements for the session were made by Roy E. Paine, who recently resigned as chairman of the Southern California District. Serving as chairman of the session was Roger E. Clark, of Metal Control Laboratories.

Papers presented included:

Improvement in Fatigue Resistance of Aluminum Alloys by Mechanical Surface Prestressing—G. A. Butz, Aluminum Company of America, and J. O. Lyst, Alcoa Research Laboratories.

Crack Propagation and the Service Fatigue Strength of Steel—Harry O. Fuchs, Metal Improvement Company.

Master Fatigue Curves—G. E. Bockrath and R. H. Christensen, Douglas Aircraft Co.

NORTHERN CALIFORNIA

Railroading in the USSR

PAUL V. GARIN, manager of mechanical engineering and research, Southern Pacific Co., and former national director of ASTM, discussed "Railroading in the USSR" at a student prize award meeting of the Northern California District in San Francisco, February 23.

Mr. Garin's talk covered the highlights of the progress made by the Soviet Union in railroading. Since the use of private automobiles is far less than in the United States, the railroads in the Soviet Union are highly organized and provide the bulk of mass transportation in that country. Because of severe winters the Soviet railroad industry faces many tests that are not commonly encountered in the United States. Prior to Mr. Garin's talk, award certificates were presented to 21 students selected from eight universities and colleges in the district.

PITTSBURGH

Nondestructive Testing

METHODS FOR FINDING both hidden and exposed defects in steel products were examined by W. A. Black, assistant director of research, Republic Steel Corp., in his talk given before a joint session of the ASTM Pittsburgh District and the Pittsburgh Section of the Society for Nondestructive Testing, Jan. 19, in Pittsburgh.

Mr. Black gave particular attention to ultrasonic testing, to which he has devoted a considerable amount of time and effort. Also, he traced develop-

AT JOINT ACI—ASTM MEETING IN LOS ANGELES, JANUARY 19

(Left to right) D. R. Butler, Integrated, Inc., ACI Southern California Chapter President; B. P. Weintz, Consolidated Rock Products Co., ACI Chapter Vice-President; ASTM President A. A. Bates, Portland Cement Assn.; Samuel Hobbs, consulting engineer, ACI Chapter Secretary-Treasurer; ASTM Executive Secretary T. A. Marshall, Jr.; and J. B. Howe, Maurseth & Howe, ASTM Southern California District Vice-Chairman.

ments in instrumentation for steel mill applications. He emphasized that in mass production operations such as in the steel industry, special consideration must be given to the need for high speed, low percentage of false rejects, ease of repeated calibration, and automatic rejection systems that are independent of personal judgment.

Arrangements for the meeting were made by E. J. Holcomb, chairman of the Pittsburgh District, and George W. Schremp, representing the Society for Nondestructive Testing.

ACR NOTES ADMINISTRATIVE COMMITTEE ON RESEARCH

Search the Literature; Get Down to Fundamentals

By J. C. HARRIS[1]

RESEARCH MEANS many things to many people, and it should, for Webster's definition shows its broad application—"a critical and exhaustive investigation or experimentation having for its aim the discovery of new facts and their correct interpretation, the revision of accepted conclusions in the light of newly discovered facts or practical application of such new or revised conclusions."

Because there are so many levels of research, it is inevitable that different attitudes exist among research workers. Many technical people who conceive of themselves as purists, that is, fundamental or basic researchers, look down upon those not so "fortunately" employed, but the fact is that a well planned and executed research study at any level can be a contribution to the systematizing of knowledge. The fundamental research person should be indebted to other research workers who use his possibly abstruse data to a practical end.

Research may be long- or short-term fundamental, but much commercial work is of the short-term, applied variety. Definite problems arise which must be solved immediately; alternatively, the effort expended in an investigation may be limited by the expected return. The quality of a research project, however, is not necessarily limited by its term. Unfortunately, the attitude in many "research" programs is either to disregard completely what may already be reported because it appears too difficult or time-consuming to ascertain, or to take the attitude that success will come from an approach that "doesn't know it can't be done." Neither is consistent with a scientific approach, and both frequently fall in the category of "quick and dirty looksees." Science, by the way, has been defined as "any department of systematized knowledge," and needed obviously are more efficient means for searching the literature, compilations of relevant data, and knowledgeable reviews correlating data from related fields. It is suggested that technical committees may productively enlarge their investigations of at least the latter two needs.

Research may be slowed or misdirected because the tremendous volume of published information has not been adequately systematized. The records (journals) become more voluminous and increase in number, and retrieval of information thus becomes more and more difficult. As fields become broader, increased specialization occurs, with further expansion of the literature. A further complication lies in the development of data for one specialty applicable to another. More time must be spent on searches of related efforts to keep abreast of developments in one's own field. Fortunately, steps are being taken to alleviate this condition, but for an immediate problem, hard, time-consuming literature work is the solution.

Technical committees already collate data from published or developed researches in a variety of forms. These may vary from statistical comparisons of analytical methods and testing machines, development of new analytical procedures and application or evaluation methods, to compilations of data. Many of the evaluation methods are end-use procedures, because these offer immediate comparison data, not necessarily based upon fundamental properties. Having proceeded to test and provide analytical methods and specifications, many subcommittees appear to reach a dead end. Needed at this point is an assessment of the fundamental properties of the materials. Collection of these fundamental data into useful form with the ultimate substitution of significant fundamental measurements for the arrays of variables present in many evaluation procedures may be desirable.

Apparent needs exist at all research levels for more effective use of the literature to minimize unproductive repetition, more effective compilation of available data, much improved retrieval of information from an increasingly vast publication of research effort, and utilization of fundamental measurements to supplement or supplant multi-variable "use" tests.

[1] Assistant Director of Research, Research and Engineering Div., Monsanto Chemical Co., Dayton, Ohio.

Information Specialists Advise in ASTM Publications Study

TO HELP in its long-range planning effort in the field of publications, the Society received the advice of a group of experts in the field of information processing who met at Headquarters on January 25. The Long-Range Planning Committee has been engaged for several years in a scrutiny of all aspects of the Society's operations in the light of changes to be expected in science and technology in the coming decade. Since the Society's contributions to the nation's economy usually take the form of a publication, the publications program is receiving particularly careful study.

One trend that will most certainly affect the future course of ASTM publications is the various schemes that are now being devised to cope with the "information problem." The burgeoning output of the technical press has spurred the rise of the information specialist, who is skilled in the arts and sciences of storing and retrieving this vast outpouring of information and the documents in which it appears.

The group was of the opinion that the planning of future ASTM publications to be compatible with information storage and retrieval systems was not a critical problem, since present systems are designed to operate on information as it is now published. However, it is possible for data and other information to be published in a form that would make it easier to store and retrieve the information.

Many in the group also felt that there is a place for interchange of information on this whole subject among the broad range of interests represented in ASTM. One result of the meeting was that an article describing approaches to solution of the problem will be prepared especially for publication in *MR&S* by Mr. John C. Costello, Jr., senior information systems engineer for Du Pont, and one of the members of the study group.

Other members of the group were: William T. Gunn, American Petroleum Inst.; L. E. Kuentzel, Wyandotte

Chemicals Corp.; John Murdock, Battelle Memorial Inst.; M. V. Otis, Tennessee Eastman Co.; and Ralph H. Phelps, Engineering Societies Library. F. Y. Speight, ASTM assistant technical secretary, served as chairman of the meeting.

BuShips Looks to ASA for Standards Lists

THE BUREAU OF SHIPS has signed a contract with the American Standards Assn., effective November 1, 1960, for the preparation of lists of industry specifications and standards which are the equivalent of military documents. This work is being done as a part of the Bureau's effort in reducing shipbuilding costs. The work will supplement and accelerate the Bureau liaison with nongovernment technical and professional societies and associations which in the past has led to the adoption of many industrial standards for Naval use.

RILEM Sets Symposium on Durability of Concrete

AN INTERNATIONAL SYMPOSIUM on the Durability of Concrete will be held as part of the 15th session of the Permanent Committee of RILEM (Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions), in Prague, Czechoslovakia, July 30 to August 6, 1961. Topics to be discussed include: theoretical questions of concrete durability, the mechanics of concrete-texture deterioration, durability tests and control, composition of durable concretes, and experiences with concrete structures. Further information can be obtained from the Czechoslovak Academy of Sciences, Institute of Theoretical and Applied Mechanics, Šolínova 7, Prague 6—Dejvice.

ASTM Publications Enter Trade Missions Program

THIS YEAR, ASTM will participate in the Trade Missions Program of the Bureau of Foreign Commerce, U. S. Department of Commerce, by contributing copies of *Materials Research & Standards* and the Book of ASTM Standards. The Bureau of Foreign Commerce will add these publications to the commercial libraries it sends to foreign countries, which are then used by Trade Mission members and our embassies and consular posts to bring to the attention of foreign businessmen the services and products available from United States firms. The publications are also read by the general public and are "forceful demonstrations of the advancements in the industrial and economic life of our nation obtained through our free-enterprise system," according to E. Paul Hawk, director of the program. As the commercial libraries are much in demand, the Bureau plans to send out approximately 50 during 1961.

Lyman E. Fourt Named DeWitt Smith Medalist

LYMAN E. FOURT, assistant director of Harris Research Laboratories, Washington, D. C., is the 12th recipient of the Harold DeWitt Smith Memorial Medal given annually by Committee D-13 on Textile Materials for outstanding achievement in the science of textile fiber use.

Dr. Fourt received the award on March 2, 1961, at the Sheraton-Atlantic Hotel in New York at the spring meeting of Committee D-13. The presentation was made by Herbert F. Schiefer of the National Bureau of Standards, chairman of Committee D-13 and the first recipient of this award in 1950. Milton Harris, vice-president of the Gillette Co., reviewed the outstanding achievements of Dr. Fourt.

The Smith Gold Medal was established and endowed by Fabrics Research Laboratories, Inc., of Dedham, Mass., in memory of Harold DeWitt Smith, who pioneered in the engineering approach to evaluation and use of textile fiber properties.

Dr. Fourt is a graduate of the University of Missouri and received his Ph. D. from Washington University in St. Louis in 1937. His professional career since that time has included research in surface chemistry, basic research on fibers, and the application of basic fiber science to technology. He first served on research staffs at the University of Chicago and Washington University and then spent several years in basic research on fibers as a research associate of the Textile Foundation at the National Bureau of Standards.

LYMAN E. FOURT

Since 1945, Dr. Fourt has been a member of the staff of Harris Research Laboratories, where his work has dealt entirely with fibers and textiles. He has made many outstanding contributions to textile science and has published 28 papers on fiber, yarn, and fabric properties. In ASTM, he is perhaps best known for his work on the evaluation of the appearance and "hand" of textiles by objective methods. His work on the luster of textiles is outstanding. He is an authority on the evaluation of the comfort properties of clothing and particularly on the passage of water vapor through textiles.

Creep and Fracture Conference Set for New York, 1963

A JOINT INTERNATIONAL conference on creep and fracture will be held August 25–28, 1963, at the Hotel Biltmore in New York, N. Y. The three sponsors are The American Society of Mechanical Engineers, The Institution of Mechanical Engineers (British), and ASTM.

Purpose of the conference is to present new ideas and to evaluate existing ones in the field of elevated-temperature mechanical properties of engineering materials. Papers are invited in the following areas:

Fundamentals of Creep and Fracture

Mechanisms—atomistic, dislocation, material or metallurgical structure, etc.

Plasticity theory in creep—theoretical and experimental studies in uniaxial or combined stresses.

Studies in relaxation, thermal and mechanical cycling, rapid and dynamic creep.

Design Techniques for Creep and Fracture

Criteria for design—uniaxial and combined stress, thermal and mechanical cycling, relaxation, and creep behavior of composite materials.

Application and interpretation of creep and fracture data—information concerning particular materials, short- and long-time tests, and extrapolation of data.

Service Experience in Creep and Fracture

Correlation—service data with laboratory tests, and methods of testing.

Environmental effects—oxidation, corrosion, ablation, erosion, radiation, etc.

Offers of papers should be sent to: Mr. N. L. Mochel, conference secretary,

Westinghouse Electric Corp., Steam Div., Lester Branch P. O., Philadelphia, 13, Pa.

Manuscripts must be in English and should be submitted as follows:

Papers from the United Kingdom, Africa, Europe, and Asia (with the exception of Japan and the USSR) should be sent to: Mr. K. H. Platt, deputy secretary, Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London S.W.1.

Papers from North and South America, USSR, and Japan should be sent to: Dr. Kenneth Merckx, Hanford Laboratories Operation, General Electric Corp., Richland, Washington.

Abstracts of not more than 250 words must be received by the above reviewers before June 1, 1962. The manuscripts must be in the hands of the reviewers by December 1, 1962.

The papers will be preprinted and distributed to all of the pre-registrants prior to the conference. This will permit the evaluation of the papers by the conferees and the preparation of written discussions before the conference.

At the conference, a reporter will abstract all of the papers for each session. The authors will serve as a panel to answer questions and to make comments on discussions offered in the session.

OTS Monthly Abstracts Cover Soviet and Chinese Journals

ABSTRACTS OF SELECTED articles from Soviet-Bloc and Communist Chinese technical journals in six general subject areas are now being published monthly and sold on subscription by the Office of Technical Services.

OTS, which is the Federal government's clearinghouse for translations and reports of government-sponsored research, offers this program in place of one discontinued last June, under which cover-to-cover abstracts of some 100 Russian journals were published. The old program was discontinued because of the small number of subscribers.

The new program does not mean a cutback in OTS services but rather a streamlining through which science and industry will get more "meat" with less reading. Rather than offering a large number of technical journals abstracted cover-to-cover, OTS is now grouping abstracts of selected articles from a much larger number of publications into six individual packages.

The time lag between publication of the original article and the appearance of the abstract is expected to be about 70 to 120 days. Approximately 1500 abstracts per month will be offered.

The Liquefaction of Helium

National Museum for the History of Science, Leiden

ONE OF the most significant events in the history of cryogenics occurred in 1908, when Kammerlingh Onnes, professor of physics at the University of Leiden, accomplished the first liquefaction of helium. From its discovery by spectroscopic observations of the sun's corona during a solar eclipse in 1868, the rare gas had defied attempts by such men as Ramsay, Dewar, and Olszewski to liquefy it. Onnes' experiment was made on July 10, 1908, with apparatus similar to what he had used previously to liquefy hydrogen. He cooled compressed helium gas by means of liquid hydrogen, then led the gas through a regenerator spiral ending in an expansion valve. It appeared for a time that the experiment would fail, even though the temperature of the helium fell below that of the liquid hydrogen. Suddenly, when the supply of hydrogen was almost exhausted, Professor Schreinemakers, assisting Onnes in the experiment, observed that the thermometer, at less than 5 degrees Kelvin, was behaving as though it were in a liquid. Closer observation showed the level of liquid helium.

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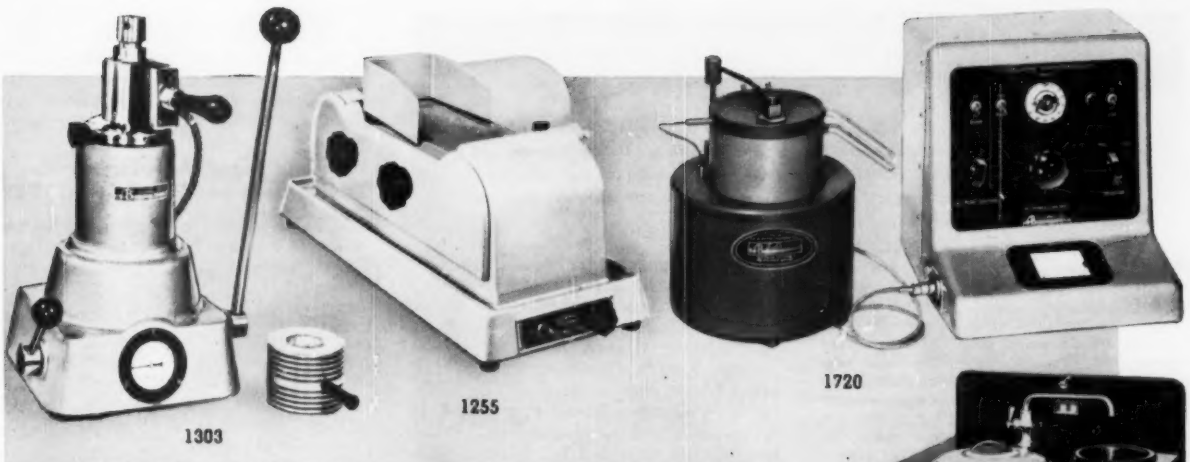

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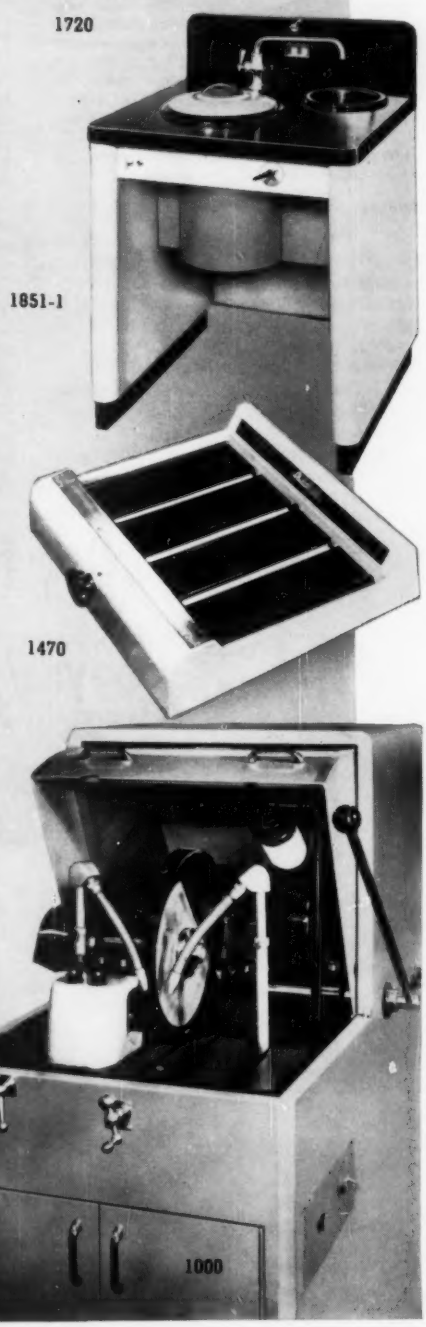

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BOOKSHELF

Members who wish to be considered for reviewing books are invited to send in their names and the subjects in which they are interested. Due to customs and mailing considerations, requests from the United States only can be considered. Copies of these books are not available through ASTM; all inquiries concerning them should be addressed to the publisher.

Radioisotope Experiments for the Chemistry Curriculum

Prepared by Nuclear-Chicago Corp. for Office of Isotopes Development, U. S. Atomic Energy Commission. Sample copy of manual with set of instructor notes available to college and university teachers at no charge upon request to Nuclear-Chicago Corp., 359 East Howard Ave., Des Plaines, Ill. Multiple copies for student use may be purchased through Nuclear-Chicago or the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C., at $2 per copy for the experimental manual and $1 per copy for the instructor notes.

Adapted from publisher's description.

THIS MANUAL IS designed to introduce the chemistry student to radioisotope techniques and to demonstrate their potential contribution to his future work. The manual reflects the growing routine use of radioisotopes as valuable tools in chemistry and biological laboratories, hospitals, industrial laboratories, and scientific research centers.

Faculty members of Northwestern University, Illinois Institute of Technology, and Pennsylvania State University participated in developing the experiments. Testing was carried out under actual teaching conditions at Pennsylvania State University, Emory University, Loyola University, St. Procopius College, Monmouth College, and Illinois Wesleyan University. Editorial supervision and administration of the project was provided by Nuclear-Chicago under a cost-sharing contract.

The experiments were developed and tested for laboratory groups of 30 students. The students themselves prepare the samples, measure their radioactivity, and interpret the results. Each of the 23 chemistry experiments is designed to be easily worked into established courses in introductory chemistry, quantitative analysis, qualitative analysis, organic chemistry, physical chemistry, biochemistry, or instrumental analysis. Ten introductory experiments illustrate the properties of radioisotopes, radiation, and the instruments involved in their detection. All the experiments may be done without special AEC license, with an inexpensive package of 13 radioactive compounds. Only basic nuclear detection equipment—a scaler, timer, Geiger tube, and mount—is required to conduct the experiments. No previous radiochemical experience by the instructor or students is necessary.

Pulp and Paper Manufacture—Bibliography and U. S. Patents, 1959

Compiled by Jack Weiner, Technical Association of the Pulp and Paper Industry, New York, N. Y. (1960), 718 pp., $7.

ANOTHER EDITION of this massive bibliography has been prepared by the Institute of Paper Chemistry for publication by TAPPI. Approximately 230 technical journals have been abstracted and some 2230 patents described covering areas of interest in the paper and allied fields.

Progress in Plastics, 1959

Edited by Phillip Morgan, The Macmillan Company, New York, N. Y., 1960; 216 pp.; $12.

Reviewed by F. W. Reinhart, National Bureau of Standards, Washington, D. C.

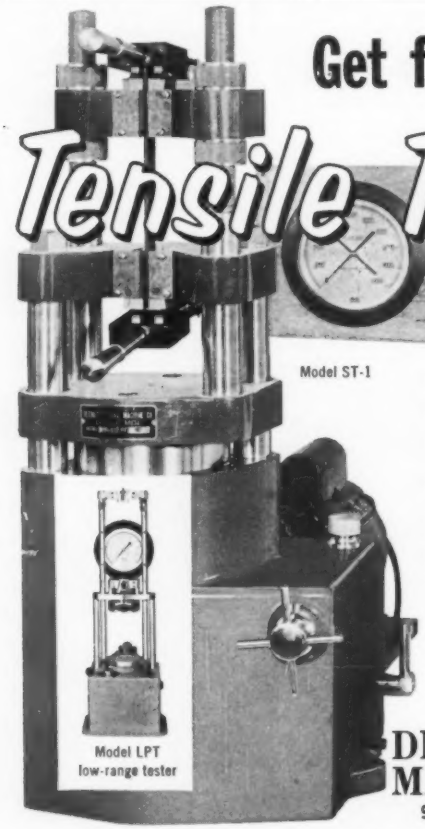
THE TECHNICAL papers presented at the International Plastics Convention held in London, England, in June, 1959, are published in this volume. Recent developments are reported on: the properties and molding characteristics of polypropylene, new epoxide resins, cross-linking of formed thermoplastics, synthesis of graft and block copolymers, basic aspects of extrusion of thermoplastics, expanded plastics, and foamed smokes.

Recent progress in reinforced-plastics engineering in the Benelux countries, Germany, the United Kingdom, and the United States is reviewed. The papers in this volume are well written and maintain a fairly good degree of uniformity in style despite the heterogenous nature of the topics.

The topics covered by no means include all those plastics subjects in which significant progress was made in 1959 or the immediately preceding period. The papers cannot be considered as reviews of recent developments but rather as discussions of progress in certain aspects of these topics. The literature references, except for one or two papers, are rather meager and in some cases nonexistent.

The subject matter will be of most use to polymer and plastics scientists and engineers interested in bringing their knowledge on the specific topics treated up to date. The uninformed expecting a review of progress in plastics in 1959 will be misled, and the informed dissappointed, if they take the title at its face value.

One wonders why these papers, most of which are good, were not published through the usual channels of the widely read scientific and technical journals rather than in a book with a misleading title. This book is an excellent example of the principle that a group of good papers presented in book form is not a sufficient requirement for a worth-while book.



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RANDOM SAMPLES

Sunspot Activity Correlates with Pipeline Voltages

RANDOM OCCURRENCES of unexplained voltages and currents of large magnitude in underground pipelines have been the subject of investigation, discussion, and speculation among corrosion engineers for many years. These effects have generally been referred to as "anomalous" currents or voltages.

About six years ago, recording voltmeters were put to work recording voltages across insulating flanges in completely different pipeline systems over 250 miles apart. During most of the 24-hr period of the recordings there was no similarity between the patterns of the voltages traced by the two recorders. During a 5-hr period on each recording, however, voltages increased radically on both recordings and formed identical patterns. This led to the belief that there was a relationship between the anomalous effects in pipelines and the variation of the earth's magnetic fields.

During the past summer, effects were noted that seem to put an end to speculation regarding the origin of the effects. On July 15, 1959, sunspot activity seriously disrupted radio communication throughout the world. An AP news release stated that the radio transmitting difficulty began at 4:00 a.m. Eastern Daylight Time.

The sunspots create magnetic storms in the ionosphere, which is that portion of the earth's upper atmosphere from which radio waves are bounced for long-range transmission. These solar eruptions in July were considered by observatory personnel in Germany to be the largest in several decades. Officials at a Munich observatory estimated that one 6-hr eruption had formed a crater the size of 50 earths.

A recording of the voltage across an insulating flange on a 24-in. naphtha pipeline was being made during this period. From 2:00 a.m., July 14, 1959, to 4:00 a.m., July 15, 1959, the recorded voltages varied between ±1.25 v. At 4:00 a.m., a radical change occurred in the voltage, its pattern and values exceeded both the positive and negative limits of the chart.

The sunspot activity continued for a period of days, during which similar recordings were obtained. After sunspot activity diminished, voltages returned to their previous value. These phenomena were noted on other underground structures of unrelated systems.

The exact correlation of the disruption of radio communications and the change noted on the chart seem to be ample proof of the origin of the "anomalous" voltages and currents.

Corrosion,
Vol. 16, No. 8,
Submitted by J. J. Meany, Jr.,
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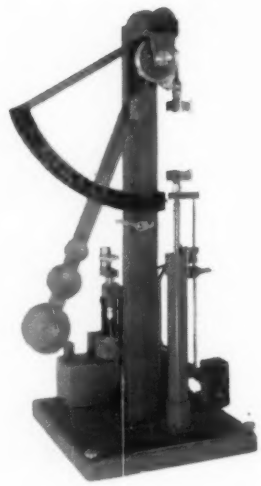

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part cement, two parts sand, and 4 parts crushed stone), and exposed to the Wisconsin weather, increased in compressive strength from 1800 psi after one month of aging to 5600 psi after 50 yr.

Chemical Engineering,
Oct. 17, 1960

Ice from the Sky

IN THE MIDDLE OF April, 1958, a shower of ice came rattling down into the yard of Mr. and Mrs. Leo Kozlowski in Napa, Calif.; big, jagged pieces of ice that were from 2 to 12 in. in diameter. Some of them buried half their length in the earth. No planes were in the area.

Then there was the remarkable experience of Edwin Groff, a farmer near Reading, Pa. He heard a whistling sound and a moment later a 50-lb chunk of ice about 2 ft in diameter smacked into the earth only a short distance from where he stood. He called his wife, and as they stood looking at the first chunk of ice, another, slightly smaller, came whistling down.

They called the sheriff . . . he called the Air Force . . . they called a meteorologist, and he called it natural ice that had been carried on the jet stream . . . that great river of air that wraps itself around the globe from west to east at speeds up to 300 mph. The jet-stream theory of the falling ice had to be abandoned for the simple reason that it could not carry chunks of ice suspended in mid-air.

Ed Groff's ice blocks came whistling down on July 30, 1957. On August 14, more ice came down in formidable chunks at Gowen City, Pa. . . . and on September 8, 1958, a whopping big chunk of ice roared through the roof of a warehouse at 510 North Third Street in Chester, Pa. Like the others, it defied any explanation that covered the facts.

Strangest of all, perhaps, was the experience that befell Mr. and Mrs. Dominic Bacigalupo of 336 Greystone Road, Old Bridge, N. J., on the night of September 2, 1958. They were watching television in their living room about 9 p.m. when Mr. Bacigalupo went to the kitchen to get himself some coffee. As he sat down in front of the TV set, there was a shattering roar . . . a chunk of ice had torn a 3-ft hole in the roof and through the ceiling of the kitchen.

As all the similar falls before it, it remains unexplained.

Most scientists admit, "This phenomenon is one of the biggest mysteries of the century . . ."

The Betz Indicator,
Vol. 28, No. 8

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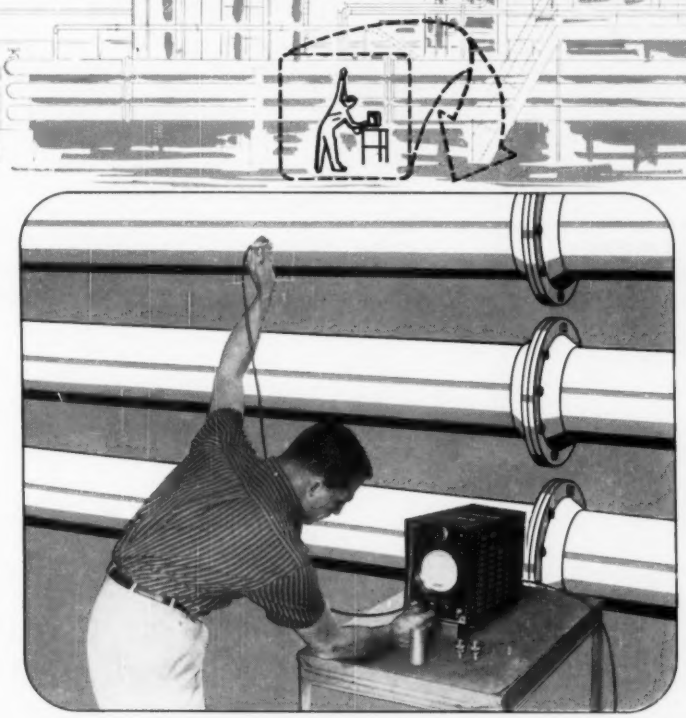

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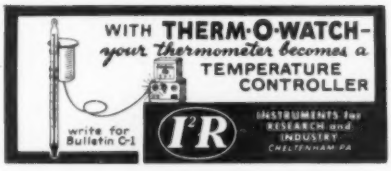

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NEW MEMBERS

The following 157 members were elected from January 8, 1961 to February 7, 1961, making the total membership 10,299 . . . Welcome to ASTM. Names are arranged alphabetically, company members first, then individuals. Your ASTM Year Book shows the areas covered by the respective Districts.

Central New York District

New York State College of Home Economics at Cornell University, Textiles and Clothing Dept., Ithaca, N. Y.

Rosenberry, Thomas L., program engineer, General Electric Co., Schenectady, N. Y. [A]*

Weiss, Volker, associate professor of metallurgy, Department of Chemical Engineering and Metallurgy, Syracuse University, Syracuse, N. Y.

Chicago District

Amoco Chemicals Corp., M. H. Arveson, development coordinator, Chicago, Ill. [S]**

Concrete Joint Inst., John J. Schmitt, consultant, Chicago, Ill.

Keystone Steel and Wire Co., J. B. Kopec, director of research and metallurgy, Peoria, Ill.

Altschaeffl, Adolph G., assistant professor of civil engineering, Purdue University, Lafayette, Ind.

Armstrong, G. Clair, architect, Armstrong & Schlichting, Minneapolis, Minn.

Balcerzak, Marion J., research engineer, Borg-Warner Corp., Des Plaines, Ill. [A]

Butzow, Neil, research engineer, Borg-Warner Research Center, Des Plaines, Ill. [A]

Filiatrault, Edward, student engineer, Northern Illinois Gas Co., Aurora, Ill. [A]

Foley, Edward J., metallurgical consultant, Milwaukee, Wis.

Kling, Robert L., chemist, product engineering, General Electric Co., Milwaukee, Wis.

Matz, Charles L., Chicago, Ill.

Nickerson, Ralph E., general manager, Ready Mix Dept., Dolese & Shepard Co., Hodgkins, Ill.

Olson Byron K., engineer, Ordnance Div., Minneapolis-Honeywell Regulator Co., Hopkins, Minn. [A]

Stephenson, T. E., Jr., resident engineer, Wisconsin State Highway Commission, Madison, Wis. [A]

Stluka, Robert T., special products engineer, Rilco Laminated Products, Inc., St. Paul, Minn. [A]

Tullett, L. E., plant metallurgist, Caterpillar Tractor Co., Aurora, Ill.

Whalen, Calvin W., industrial engineer, Aluminum Company of America, Davenport, Iowa. [A]

Cleveland District

Molded Fiber Glass Cos., Richard H. Ackley, department head, Test Laboratory Ashtabula, Ohio.

National Carbon Co., A Division of Union Carbide Corp., W. K. Cheuvront, head of specifications, Cleveland, Ohio.

Bock, W. K., director of research, National Malleable and Steel Castings Co., Cleveland, Ohio.

Carlson, Carl A., partner, Wilbur Watson Associates, Cleveland, Ohio.

Eva, William A., Jr., works metallurgist, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio.

Frahme, H., general manager, Alite Div., U. S. Stoneware Co., Orrville, Ohio.

Guidotti, Alfred A., plant superintendent, Colonial Woolen Mills Co., Cleveland, Ohio.

Lysyk, Ralph, manager, Engineering Services, Jack & Heintz, Inc., Cleveland, Ohio.

Sproul, James D., Jr., sales engineer, Allied Engineering, Cleveland, Ohio. [A]

Detroit District

Cioth, Nikandr S., development engineer, Huck Manufacturing Co., Detroit, Mich. [A]

Ford, James A., instructor, University of Michigan, Ann Arbor, Mich. [A]

Lang, Howard E., manager, quality control engineering, Fruehauf Trailer Co., Detroit, Mich. [A]

Mississippi Valley District

Baldwin, James W., Jr., associate professor of civil engineering, University of Missouri, Columbia, Mo. [A]

Johnson, Bobby G., material and process engineer, McDonnell Aircraft Corp., St. Louis, Mo. [A]

New England District

Associated Spring Corp., Ronald D. Crooks, metallurgist, Bristol, Conn.

Ruthland Fire Clay Co., Robert A. Hackett, technical director, Rutland, Vt.

Bogue, I. R., supervisor, Electrical Testing Laboratory, The J. M. Ney Co., Hartford, Conn.

Curtis, John H., research director, Vermont Marble Co., Proctor, Vt.

Daly, Albert J., technical director, Howe & French, Weymouth, Mass.

Dickinson, Robert H., supervisor, Incandescent Lamp Design, Sylvania Electric Products, Inc., Salem, Mass.

Eagan, Henry F., technical director, International Packings Corp., Bristol, N. H.

Hodgkins, W. C., Jr., quality control group leader, Research and Development Dept., Great Northern Paper Co., Millinocket, Me.

Jordan, Edward C., president, E. C. Jordan Co., Inc., Portland, Me.

McSweeney, Thomas F., senior associate, Thomas F. McSweeney Associates, Hingham, Mass.

Meyers, George A., research engineer, Sylvania Electric Products, Inc., Danvers, Mass.

Perkins, Carl W., Jr., laboratory supervisor, Electric Boat Div., General Dynamics Corp., Groton, Conn.

Rooney, John F., engineer, building design, Ganteaume & McMullen, Boston, Mass.

New York District

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Lipton, Thomas J., Inc., Harold N. Graham, manager, Food Research Section, Hoboken, N. J.

Thomas & Betts Co., Inc., The, Edward P. Mack, project engineer, Elizabeth, N. J.

Atatimur, Yalcin H., Bloomfield, N. J.

Cassie, Norman M., research manager, Standard Insulation Co., East Rutherford, N. J.

Chiari, Bruno V., assistant manager, Universal Atlas Cement Div., United States Steel Corp., New York, N. Y.

Decker, Raymond F., supervisor, Nickel and Stainless Steel Research, The International Nickel Co., Inc., Bayonne, N. J.

Devlin, Parker H., owner, Parker Devlin Co., Westport, Conn.

Griffin, Kenneth, textile engineer, Staten Island, N. Y. [A]

Levy, S. Boaz, associate, Arnold H. Vollmer Associates, New York, N. Y.

* A denotes Associate Member
** S denotes Sustaining Member

(*Continued on page 236*)

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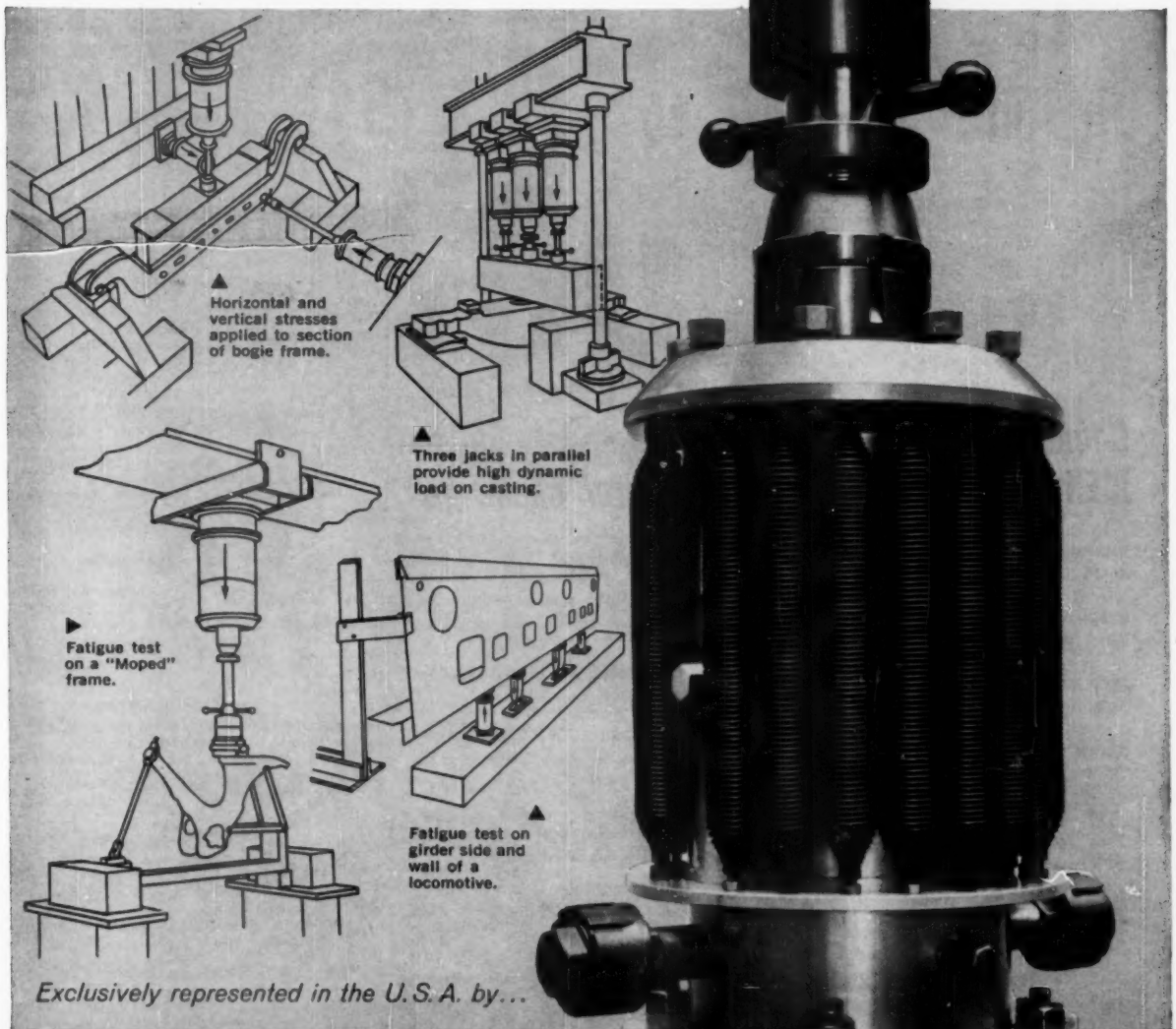
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NEW MEMBERS

(*Continued from page 234*)

London, Jacob, partner, Steinman, Boynton, Gronquist & London, New York, N. Y.
Parker, Philip S., district staff engineer, The H. K. Ferguson Co., New York, N. Y.
Patel, Ashok M., trainee, Noritake Co., Inc., New York, N. Y. [A]
Reilly, William E., research and development metallurgist, Engelhard Industries, Inc., Newark, N. J.
Sherwood, Rexford D., research associate, Isotopes, Inc., Westwood, N. J.
Tarangelo, James A., process engineer, W. R. Grace and Co., Clifton, N. J. [A]
Veterans Administration, Prosthetics Center, Otto Rothman, chief, Testing and Development Laboratory, New York, N. Y.

Northern California District

No-Joint Concrete Pipe Co., C. T. NcNeill, secretary, Yuba City, Calif.
Raychem Corp., Vincent L. Lanza, director, Research and Development Div., Redwood City, Calif.
Diamond, John W., supervisor, Metallurgical Laboratory, Aerojet-General Corp., Sacramento, Calif.
Schulz, Walter G., vice-president, Leeds, Hill & Jewett, Inc., San Francisco, Calif.
Teter, Donald O., chief building inspector, City of Fremont, Fremont, Calif.

Northwest District

Cummins, Harold G., Industrial Div., Pacific Scientific Co., Seattle, Wash.
Loomis, John S., Jr., nuclear engineer, General Electric Co., Hanford Atomic Products Operation, Richland, Wash. [A]
Markham, Aaron E., research group leader, Puget Sound Pulp and Timber Co., Bellingham, Wash.
Nelson, Marvin E., trainee, General Telephone Company of the Northwest, Spokane, Wash. [A]
Potter, Irvin A., materials engineer, King County Engineers, Seattle Wash.
Roots, W. K., vice-president, engineering, Mears Controls, Inc., Portland, Ore.
Sinclair, Roger L., design engineer, Richard T. Worthington, Consulting Engineers, Corvallis, Ore. [A]
Upton, George M., Jr., graduate school, University of Washington, Seattle, Wash. [A]
White, Oscar A., assistant engineer of materials, Oregon State Highway Dept., Salem, Ore.
Willis, Douglas T., president, Terra Engineering Laboratories, Ltd., Victoria, B. C., Canada.
Worth, Harold Edward, forest products technologist, U. S. Forest Service, Portland, Ore.

Ohio Valley District

Dautenhahn, Tom, materials engineer, Westinghouse Electric Corp., Lima, Ohio. [A]
Hanink, Dean K., chief metallurgist, Allison Div., General Motors Corp., Indianapolis, Ind.
Hardin, L. S., assistant research engineer, Kentucky State Highway Dept., Frankford, Ky. [A]
Jennings, William M., Jr., sales supervisor, Ex-Cell-O Corp., Lima, Ohio. [A]
Marshall, Marion H., Proctor & Gamble, Cincinnati, Ohio. [A]
Mayer, Paul H., engineer, Western Electric Co., Inc., Columbus, Ohio. [A]
Rayo, Mariano A., chemist, The Franklin Glue Co., Columbus, Ohio.

Philadelphia District

Electric Hotpack Co., Inc., The, Sidney Ladenson, chief engineer, Philadelphia, Pa.
Snow White Bleachery, Inc., Russell V. Zerbe, general manager, Royersford, Pa.
Cameron, Colin F., cellulose products superintendent, Sales Development Laboratory, E. I. du Pont de Nemours and Co., Inc., Penns Grove, N. J.
Price, Daniel E., engineer, Philco Corp., Ft. Washington, Pa.
Weber, Frederic L., in charge, Air Pollution Control Laboratory, Philadelphia Public Health Dept., Philadelphia, Pa.
Weiss, William L., test engineer, Vertol Div., Boeing Airplane Co., Morton, Pa. [A]

Pittsburgh District

Knapp, John P., research director, Roessing Bronze Co., Pittsburgh, Pa.
Link, Harold S., research engineer, U. S. Steel Corp., Monroeville, Pa.
Zabban, Walter, partner, The Chester Engineers, Pittsburgh, Pa.

Rocky Mountain District

Protex Div., Autolene Lubricants Co., William B. Plourd, concrete engineer, Research and Engineering Laboratories, Denver, Colo.
Jonassen, Gaylord D., staff trainee, technical, Western Electric Co., Inc., Phoenix, Ariz. [A]
Quanbeck, Kermit L., engineer, The Martin Co., Denver, Colo. [A]
Sloan, George G., chief chemist, Kermac Nuclear Fuels Corp., Grants, N. Mex.
Westgaard, Tor, architect, Alamosa, Colo.
Witzel, John, III, design and test engineer, Hercules Powder Co., Bacchus, Utah. [A]

Southeast District

Edwards, W. Thomas, III, associate engineer, Lockheed Aircraft Corp., Marietta, Ga. [A]
Estes, Edward R., Jr., chief engineer, Florida Steel Corp., Tampa, Fla.
Hampton, Burt L., director, Research and Development, Nelio Chemicals, Inc., Jacksonville, Fla.
Kestler, Charles B., manager, Technical Information Branch, ARO, Inc., Arnold Air Force Center, Tenn.

(*Continued on page 238*)

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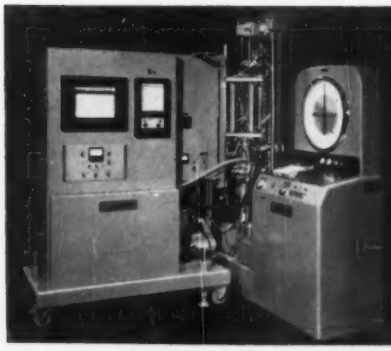

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NEW MEMBERS

(*Continued from page 236*)

Smith, Richard L., supervisor, Process Control Laboratory, Lockheed Aircraft Corp., Marietta, Ga.
Williams, C. D., partner, Patchen, Mingledorff & Williams, Augusta, Ga.

Southern California District

Thompson, H. I., Fiber Glass Co., Leon Parker, vice-president, Engineering and Research, Los Angeles, Calif.
Adams, Byron Grant, chief chemist, Palomar Oil and Refining Corp., Bakersfield, Calif.
Aten, Jerold W., assistant chief chemist, Shell Chemical Co., A Division of Shell Oil Co., Torrance, Calif.
Girvin, John H., highway engineer trainee, Bureau of Public Roads, Washington, D. C. [A]
Newhouse, Robert R., civil engineering assistant, Los Angeles Department of Water and Power, Los Angeles, Calif. [A]
Nisbet, Walter W., application engineer, customer relations, The Marquardt Corp., Van Nuys, Calif. [A]

Southwest District

Perkins, C. A., Inspection Co., Inc., C. A. Perkins, president, Shreveport, La.
Dumas, Theodore A., engineer trainee, Hughes Tool Co., Houston, Tex. [A]
Murchison, H. L., chief, Specifications and Industrial Architectural Div., Lockwood, Andrews & Newman, Inc., Houston, Tex.
U. S. Bureau of Reclamation, Amarillo, Tex.

Washington, D. C., District

Melpar, Inc., Paul E. Ritt, director of research, Falls Church, Va.
Poly-Scientific Corp., E. W. Glossbrenner, director, Research and Testing Laboratory, Blackburg, Va.
Anthony, John A., Jr., mechanical engineer, design, Norfolk Naval Shipyard, Portsmouth, Va.
Beavin, Benjamin E., owner, Benjamin E. Beavin Co., Baltimore, Md.
Bryan, John L., professor and head, fire protection curriculum, University of Maryland, College Park, Md.
Conway, George O., Jr., estimating and construction engineer, National Paving and Contracting Co., Baltimore, Md.
Fisher, Charles Page, Jr., instructor, civil engineering, North Carolina State College, Raleigh, N. C.
Gelazela, Gerald J., development engineer, E. I. du Pont de Nemours and Co., Inc., Curtis Bay, Baltimore, Md. [A]
Kline, Donald Hasbrouck, partner, W. H. Gardner, Jr., and Associates, Durham, N. C. [A]
Neubauer, Donald J., consulting engineer, Washington, D. C.
Nichols, Troy R., chemist, Aberdeen, Md. [A]
Pojawis, Paul L., manager, technical services and development, Lord Baltimore Press, Baltimore, Md. [A]
Verno, Louis J., manager, coal evaluation, Clinchfield Coal Co., Dante, Va.
Wahls, Harvey E., assistant professor, Department of Civil Engineering, North Carolina State College, Raleigh, N. C. [A]
Yoakum, Anna M., senior research chemist, The Chemstrand Research Center, Inc., Durham, N. C. [A]
Young, Earle W., Jr., mechanical engineer, National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md. [A]

Western New York–Ontario District

Genung, Leo B., cellulose technology director, Eastman Kodak Co., Rochester, N. Y.
Judd, Douglas G., director of purchasing and stores div., City of Toronto, Toronto, Ont., Canada.
Soures, Nicholas M., associate engineer, Haloid Xerox, Inc., Rochester, N. Y. [A]
Vanesche, Henry Louis, chemist, Ontario Water Resources Commission, Etobicoke, Ont., Canada.

Outside Established Districts

Becker, Robert H., assistant engineer, University of Nebraska, Lincoln, Nebr.
Fasig, Edgar W., Jr., ensign, Civil Engineer Corps, U. S. Department of the Navy, New York, N. Y. [A]
Kittler, Herb, laboratory general manager, Arctic Alaska Testing Laboratories, Box 843, Fairbanks, Alaska.
Mau, K. T., plant manager, Hawaiian Cement Corp., Waipahu, Hawaii.
Mundy, Norman L., project engineer, Hood-Thompson Construction Co., Honolulu, Hawaii.

Other Than U. S. Possessions

Carr, George Clifford, technical adviser, Council of British Manufacturers of Petroleum Equipment, London, England.
Duquette, Douglas D., assistant professor, Civil Engineering Dept., Essex College, Windsor, Ont., Canada. [A]
East Pakistan Forest Research Laboratory, M. Omar Ali, divisional officer, Forest Dale, Sholashahar, Chittagong, East Pakistan.
Gazi, Arif Suleman, quality control dept., Latif Bawany Jute Mills, Ltd., Decca, East Pakistan.
Gibson, Gary L., junior assistant engineer, Canadian National Railways, Moncton, N. B., Canada. [A]
Hushion, D. H., chief engineer, Alberta Gas Trunk Line Co., Ltd., Calgary, Alta., Canada.
Idorn, Gunnar M., head of laboratory, Aktieselskabet Aalborg-Portland-Cement-Fabrik, Christians Brygge, Copenhagen, Denmark.
Nobili, Paolo, road engineer, Rome, Italy. [A]
Rosseau, Pierre, engineer, Paris, France.
Roy, Louis Philippe, survey director, Laval Industrial Assn., Inc., Montreal, P. Q., Canada.
Sella, J. K., chief librarian, State of Israel, Ministry of Defense, Scientific Dept., Tel-Aviv, Israel.

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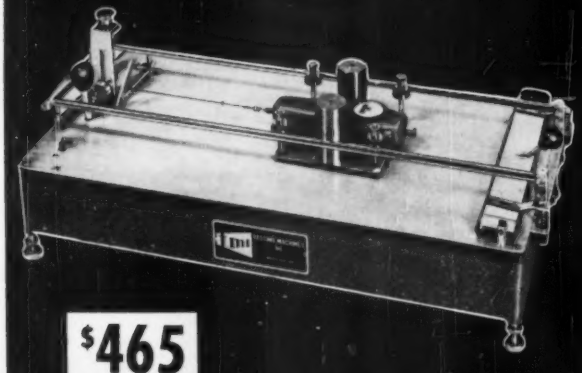

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Solano Puyana, Luis F., professor of metallurgical engineering, Universidad Industrial de Santander, Santander, Colombia. [A]

Solar L., Juan Del, technical assistant, Wires and Cables Committee, Inditecnor, Santiago, Chile.

Ueshima, Shigeo, president, Ueshima Seisakusho, Ltd., Tokyo, Japan.

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dc Voltage Instruments, 15 to 1000 v Full Scale, PB 171217

dc Voltage Instruments, 1 to 1500 mv Full Scale, PB 171218

CROSS-CHECK PROCEDURE

Standard Resistors, NBS Type, 1 Ohm to 100,000 Ohms (Using Leeds & Northrop 4232-A1 Bridge), PB 171200

Standard Inductors, 100 μh to 10 h, General Radio 1482 Series (Using GR 1632 A Bridge), PB 171201

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Force 0 to 60,000 lb (Approx.), Tension only, PB 171203

Voltage Standing Wave Ratio, X-Band, (8.20 to 102.40 kMc), 1.01:1 to 10:1, PB 171204

dc Resistance, 0.00001 to 1.0 Ohm, PB 171205

dc Resistance, 0.1 Ohm to 100 Megohms, PB 171206

dc Resistance, 10 Ohms to 1,000,000 Meghoms, PB 171207

Inductance, 1.0 μh to 10 h, Direct Method, PB 171208

ac and dc Voltage, 10 to 1000 v, PB 171212

ac Voltage, 0.0001 to 800 v, 60 cps, PB 171213

dc Voltage, 1.02 to 1000 v, PB 171214

dc Voltage, 0 to 1000 v, PB 171215

Frequency Response 10 cps to 10 Mcps, 0.5 mv to 5.2 v and ac Voltage Calibration dc to 10 Mcps, 0.1 to 5.2 v, PB 171216

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FOR FURTHER INFORMATION CIRCLE 980 ON READER SERVICE CARD

NEWS OF MEMBERS

The American Chemical Society has named 23 members to serve on the advisory board of the ACS Applied Publications. Two ASTM members, **Edward C. Dunlop,** E. I. du Pont de Nemours and Co., Inc., Wilmington, Del, and **Melvin L. Moss,** Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa., will serve on the advisory board of *Analytical Chemistry*.

Several ASTM members were among the recipients of the American Concrete Inst. awards for 1960. **Stanton Walker,** director of engineering, National Sand and Gravel Assn., Washington, D. C., received the Turner Medal "for his many contributions to the basic knowledge of concrete through published literature and active participation in the work of technical committees of the Institute;" **A. Allan Bates,** ASTM president, and vice-president of the Portland Cement Assn., Chicago, Ill., received the Kennedy Award "for untiring efforts as chairman and member of the ACI Building Committee, successfully culminated in the outstanding architectural masterpiece housing the Institute Headquarters"; and **Henry T. Toennies,** assistant director of engineering, National Concrete Masonry Assn., Washington, D. C., was awarded the Wason Medal for Research for his paper, "Artificial Carbonation of Concrete Masonry Units." The Wason Medal rewards the ACI member making the most noteworthy research reported in an ACI paper during the publication year. **Treval C. Powers,** manager, basic research, Portland Cement Assn., Chicago, Ill., was elected to honorary membership. His many contributions, which have led to a better understanding of the chemical and physical phenomena underlying the formation of concrete from its component materials, were the basis for the honor.

At the 28th meeting of the Surface Preservation Section, Production Techniques Div., American Ordnance Assn., held at El Paso, Tex., and White Sands Missile Range, N. Mex., new officers were elected. **Myron B. Diggin,** vice-president and director, Hanson-Van Winkle-Munning Co., Matawan, N. J., was elected section chairman, and **R. B. Saltonstall,** technical director, Udylite Corp., Detroit, Mich., was elected secretary.

E. O. Mattocks, director of technical services, American Petroleum Inst., New York, N. Y., has been elected vice-chairman of the Standards Council of the American Standards Assn. Elected to serve on the Board of Review of the Standards Council were: **Richard B. Belford,** technical advisor, Industrial Fasteners Inst., Cleveland, Ohio; **J. S. Fassett,** director, Membership Services Dept., American Hotel Assn., New York, N. Y.; **C. M. Heinen,** assistant chief engineer, Chrysler Corp., Detroit, Mich.; **J. W. W. Sullivan,** American Iron and Steel Inst., New York, N. Y.; and **Mr. Mattocks.**

Johns-Manville Research Center, Celite Research Dept., Manville, N. J., has appointed **Herman C. Fisher** chief of the Cement Additives Section. **Laurence E. Weymouth** has been named research technologist.

1961 officers of the American Concrete Inst. include the following ASTM members: **Lewis H. Tuthill,** concrete engineer, California State Dept. of Water Resources, Sacramento, Calif., president; **Raymond C. Reese,** consulting engineer, Sandusky, Ohio, second year as a vice-president; and **Arthur R. Anderson,** consulting engineer, Tacoma, Washington, and **Chester P. Siess,** research associate professor, civil engineering, University of Illinois, Urbana, Ill., new members of the Board of Direction.

W. O. Binder, assistant director of development, Union Carbide Metals Co., was transferred to the Union Carbide Development Co. With Headquarters in Geneva, Switzerland, Mr. Binder will maintain contact with European steel industry in order to keep the company abreast of developments in the metallurgical industry there.

Jesse I. Black is now in quality assurance, Autonetics, Division of North American Aviation, Inc., Downey, Calif. Formerly he was chemist, Shell Oil Co., Torrance, Calif.

Bonner S. Coffman, formerly consulting engineer, Glen Echo, Md., is now associate professor, Ohio State University, Columbus, Ohio.

Harry R. Copson, head, Corrosion Section, The International Nickel Co., Inc., Research Laboratory, Bayonne, N. J., received the National Association of Corrosion Engineers' 1960 Whitney Award.

John G. Dempsey, formerly president, Prestcrete Corp., Plano, Ill., is now director of engineering, Robert L. Novak and Co., Des Plaines, Ill.

Donald C. Dieterly, formerly supervisor of magnetic testing, Armco Steel Corp., Middletown, Ohio, is supervisor of magnetic materials applications.

Herbert L. Forman is now associated with Pall Corp., Glen Cove, N. Y., as engineer. He had been engineer in charge, Engineering Laboratories, Purolator Products, Inc. Rahway, N. J.

A. T. Hague, a member of ASTM since 1928, retired December 31, 1960, from Asphalt Sales, Standard Oil Co. (Indiana), Chicago, Ill.

Carl F. Joseph, a 30-year member of ASTM, has retired as technical director, Centray Foundry Div., General Motors Corp., Saginaw, Mich., after 43 years of service.

John L. Kronau is now chairman, Maryland Port Authority, Baltimore,

(*Continued on page 242*)

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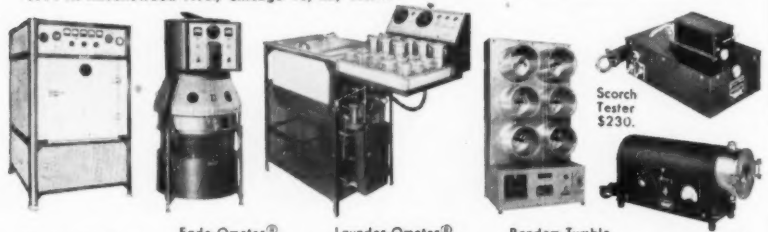

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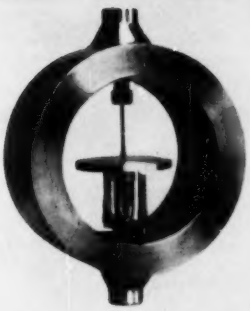
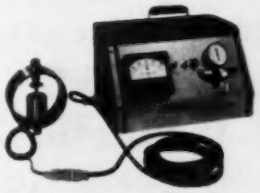
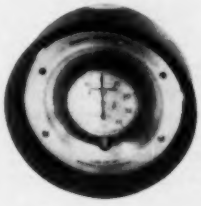


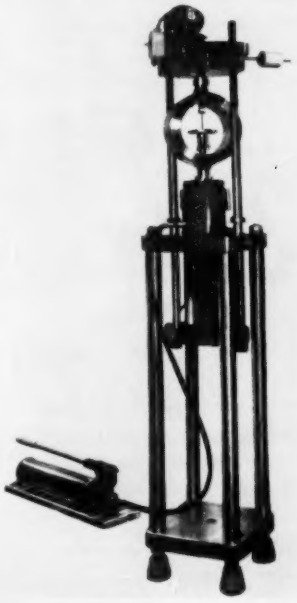
PROVING RINGS



CALIBRATING SYSTEMS



RING DYNAMOMETERS



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1. PROVING RINGS — The Morehouse Proving Ring is by far the most widely used and accepted instrument for calibrating physical testing machines, thrust stands, dynamometers and other forces measurement equipment. The reason for this is elementary . . its basic simplicity assures highly accurate retention of original calibration for long periods of time. Consisting simply of an elastic steel load ring and a vibrating reed-micrometer screw deflection measuring system, it is unsurpassed as a transfer standard because of its dependable repeatability. With moderate care, the Morehouse Proving Ring will perform well within its specification limits of 1/10 of 1% for years. Every one is calibrated and certified by the National Bureau of Standards to their specification, LC-822.

To further facilitate the use of the Proving Ring, an electrical reed vibrator powered by a self-contained mercury cell is now available for easy installation on new and existing instruments. This vibrator helps even the most inexperienced operator achieve greater accuracy through more consistent dampening of the reed. Since the vibrator's action dampens out at very slight pressure, it increases the ultimate accuracy of the Proving Ring due to heightened sensitivity.

2. CALIBRATING SYSTEMS — The Morehouse Calibrating System provides a high degree of accuracy to remote operation and indication. It consists of a steel load ring with a diametrically-mounted differential transformer and an electronic balancing instrument. Unlike other electronic systems, however, it does not depend on the measurement of electrical signals. The electronic system serves only as a means of transferring the force signal (deflection of the load ring as sensed by the differential transformer) to a micrometer screw contained in the balancing instrument. This feature eliminates the possibility of any inaccuracies which may be magnified or diminished in the instrument circuit. Calibration readings are made by turning the micrometer screw dial until a null-balance is achieved—as indicated on a precision null-balance meter.

Every Morehouse Calibrating System is calibrated by the National Bureau of Standards and provides accuracies well within 1/10 of 1%. The balancing instrument may be teamed with various capacity load rings for a broad calibration range.

3. RING DYNAMOMETERS — The Morehouse Ring Dynamometer is an easy-to-use instrument for checking Brinell hardness testers, certain universal testing machines, presses and other force measurement systems. It consists primarily of a load ring with a precision dial indicator to show deflection. Because of the limitations of dial indicators, accuracies of 1/10 of 1% of range are only assured at pre-calibrated loads. Normally, ten loads in increments of 1/10 of capacity are calibrated by the National Bureau of Standards. However, special loads can be calibrated to meet specific requirements.

4. UNIVERSAL CALIBRATING MACHINES — The Morehouse Universal Calibrating Machine facilitates the calibration of load cells which can not be accurately calibrated in their normal operating position. The Calibrating Machine provides a highly accurate method for applying force to a load cell and a proving ring simultaneously. The force is produced by a precision, two-speed pump especially designed for calibration work.

The entire Calibrating Machine has been designed solely for accuracy. The free-moving yoke completely eliminates friction between the proving ring and the load cell. The Machine and its accessories assure axial loading, too, as non-axial loading contributes to inaccuracies.

A recent innovation, an adjustable yoke, compensates quite simply for various size load cells. It also facilitates the lifting of the yoke and load cell during set-ups.

5. SPECIAL APPLICATIONS — Many companies have called on us to apply our long-gained experience to special load calibration problems. In some instances, we have developed systems for permanent installation where highly accurate force measurements or continual calibrations were required. Also in keeping with our leadership and service in the field, we will have a 1,000,000-pound proving ring available on a rental basis shortly after the National Bureau of Standards' new 1,000,000-pound dead-weight machine is operable.

For complete information on these instruments or help on special force measurement and weighing problems, write to:

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NEWS OF MEMBERS

(*Continued from page 240*)

Md. He had been president and treasurer, Patapsco Engineering Co., Inc., Baltimore, Md.

Lester E. Kuentzel is now research associate, Wyandotte Chemicals Corp., Wyandotte, Mich. Formerly he was senior research chemist.

Frank E. Lobaugh, manager, Lumnite Div., Universal Atlas Cement Div., United States Steel Corp., New York, N. Y., retired March 1, 1961. Mr. Lobaugh has been a member of ASTM since 1947 and has served on Committees C-3 on Chemical-Resistant Mortars and C-8 on Refractories.

Charles A. Lyon, formerly special assistant to the vice-president for marketing, The Master Builders Co., Cleveland, Ohio, is now vice-president, Nesso Master Builders, Kabushiki Kaisha, Tokyo, Japan.

Hamilton Migel has been appointed vice-president for planning new products and product development for Magnaflux Corp., Chicago, Ill. He was vice-president in charge of engineering and research.

Darwin A. Novak, Jr., formerly chemical engineer, Mallinckrodt Chemical Works, St. Charles, Mo., is now research chemical engineer, Monsanto Chemical Co., St. Louis, Mo.

Gerhard Otto is now a member of the technical staff, Pacific Semiconductors, Inc., Culver City, Calif. Formerly he was with Metal Control Laboratories, Inc., Huntington Park, Calif.

Franklyn C. Rogers has been appointed chief civil engineer, Harza Engineering Co., Chicago, Ill. He had been staff engineer.

H. A. Sawyer, president, Lone Star Cement Corp., New York, N. Y., has been elected chairman of the board of directors, Portland Cement Assn., Chicago, Ill.

Ralph A. Schaefer has been appointed director of research, Electric Storage Battery Co., Toledo, Ohio. Formerly he was director of engineering and research, Bunting Brass and Bronze Co., Toledo, Ohio.

Harold C. Stone has been appointed chief metallurgist, American Steel Treating Co., Crystal Lake, Ill. He had been director, Metallurgical Laboratory.

T. E. Terry, senior partner, Wilbur Watson Associates, Cleveland, Ohio, retired December 31, 1960. Mr. Terry's membership in ASTM dates back to 1945.

A. H. Tessmann is now vice-president, Central Cable Corp., Tucker, Ga. Formerly he was president, Industrial Research and Development Corp., Chattanooga, Tenn.

John F. Thompson, honorary chairman of the board, The International Nickel Company of Canada, Ltd., New York, N. Y., was elected to honorary membership in the American Institute of Mining, Metallurgical, and Petroleum Engineers. This high honor recognizes him as "a metallurgist, scientist, and administrator whose early appreciation of the unique qualities of nickel brought immense benefits to the world as well as outstanding success to the vast enterprise he has directed."

J. S. Vanick, consultant, Sea Girt, N. J., retired metallurgist, The International Nickel Co., Inc., N. Y., has joined the editorial staff of *Modern Castings*.

T. Z. Voyda, formerly technical director, Hubbard-Hall Co., Waterbury Conn., is now assistant vice-president.

K. G. Wikle has been named technical manager of beryllium alloy operations and chief metallurgist at Brush Beryllium Co.'s newly established Works Process Engineering Dept., Elmore, Ohio.

Michael J. Wilson is director of engineering, M. J. Engineering Co., Chicago, Ill. Formerly he held the same position with E. Edelmann and Co., Chicago, Ill.

DEATHS

Robert W. Anderson, partner, Ganteaume & McMullen, Boston, Mass. (October 1960). Mr. Anderson, a member of ASTM since 1956, was killed in an airplane crash in Boston.

Alfred C. Barbour, manager, Roessing Bronze Co., Etna, Pa. (January 4, 1960). Mr. Barbour became associated with the Society in 1944.

Sigfrid Dahlberg, supervisor, Laboratory of Industrial Hygiene, Fidelity and Casualty Co., New York, N. Y. (December 16, 1960). Mr. Dahlberg was a victim of the recent midair collision over New York.

John R. Dwyer, Bethesda, Md., retired research associate, National Bureau of Standards, Washington, D. C. (January 26, 1961). During his 40 years of ASTM membership, Mr. Dwyer was very active in committee work. He was an honorary member of committee C-1 on Cement, and a member of Committees C-12 on Mortars for Unit Masonry and C-9 on Concrete and Concrete Aggregates. He also served on the Washington, D. C., District Council from 1950 to 1956.

Marion Eppley, president, The Eppley Laboratory, Inc., Newport, R. I. (November 22, 1960). Mr. Eppley joined ASTM in 1936.

H. J. Eyman, manager, general metallurgy, United States Steel Corp., Pittsburgh, Pa. (April 1960). Mr. Eyman's membership in ASTM dates back to 1948.

Marc S. Goldsmith, president and general manager, Goldsmith Bros. Smelting and Refining Co., Chicago, Ill. (recently). Mr. Goldsmith was a member of

the Society for more than 15 years, and also a member of Committee B-2 on Non-Ferrous Metals and Alloys.

A. N. Goodbrand, Goodbrand and Co., Ltd., Stalybridge, Cheshire, England (January 2, 1961). Mr. Goodbrand joined the Society in 1949.

W. Hertner, Pratteln, Switzerland (recently). Mr. Hertner had been a member of ASTM for a little over a year.

W. W. Hodge, senior fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa. (January 23, 1961). Mr. Hodge joined ASTM in 1947 and represented the Manufacturing Chemists Assn., Inc., on Committee D-19 on Industrial Water.

Victor P. Krauss, Bureau of Standardization, Engineering Div., Department of Purchase, New York, N. Y. (January 31, 1961). Mr. Krauss represented the bureau on Committee D-1 on Paint, Varnish, Lacquer and Related Products.

G. F. McConnell, Mosaic Tile Co., Zanesville, Ohio (recently). Mr. McConnell represented his company on Committee C-21 on Ceramic Whitewares and Related Products.

Robert J. Peters, chief metallurgist, Warner Gear Div., Borg-Warner Corp., Muncie, Ind. (February 27, 1960). Mr. Peters represented his company in Society membership.

William P. Putnam, 2500 W. Ten Mile Road, Southfield, Mich. (January 26, 1961). Mr. Putnam, when he retired in 1948, was president, Detroit Testing Laboratory, Inc., which he founded in 1903. He was in his 50th year of ASTM membership.

Prior to his retirement, Mr. Putnam was active in Committees A-3 on Cast Iron, A-7 on Malleable-Iron Castings (chairman from 1924 to 1936), E-5 on Fire Tests of Materials and Construction, E-8 on Nomenclature and Definitions, ASA A-21 on Specifications for Cast-Iron Pipe and Fittings, and the Detroit District Council, of which he was vice-chairman from 1944 to 1946 and secretary from 1942 to 1944.

W. W. Roff, vice-president, Whittaker, Clark & Daniels, Inc., New York, N. Y. (January 16, 1960). Mr. Roff was his company's representative in Society membership.

James F. Tompkins, president, Industrial Kanigen Corp., Emeryville, Calif. (recently). Mr. Tompkins had been a member of the Society for only a short time.

Vito A. Villani, structural engineer, Soil Testing Laboratory, Sauti, Consulting Engineers, Ahwaz, Iran (January, 1960). Mr. Villani was killed in an automobile accident shortly after joining ASTM.

Anthony D. Wagner, partner, Ira S. Latimer Co., Van Dyke, Mich. (December 5, 1960). Mr. Wagner had been a member of the Society since 1944.

John H. Wickersham, president, John H. Wickersham Engineering and Construction, Inc., Lancaster, Pa. (July 26, 1960). Mr. Wickersham had been a member of the Society for almost 30 years.

T. F. Wieczorek, sales manager, Eastern Products Corp., Baltimore Md. (recently). He joined ASTM in 1958.

MATERIAL QUESTIONS

NEARLY EVERY day the mail at ASTM Headquarters includes some questions about materials, specifications, test methods, or related problems. We feel that the answers, many of which are based on information given us by officers of committees in their capacity as committee officers, are of general interest. For the most part inquiries we receive relate to the activities of the Society, either standards, research work, or publications. Often, an inquiry is such that the services of a consultant or independent testing or research laboratory is obviously required; in this event we do not hesitate to so recommend.

Preparing Rubber Test Samples

Methods of Sample Preparation for Physical Testing of Rubber Products

(*Continued on next page*)

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FOR FURTHER INFORMATION CIRCLE 984 ON READER SERVICE CARD

MATERIAL QUESTIONS

(*Continued from preceding page*)

(D 15) require that temperature of curing molds be controlled with ±1 F. Does this refer to the temperature at one point in the mold, or over the whole surface of the mold? In other words, would the automatic temperature controls be activated by one thermocouple or by several? We are planning installation of electrically heated mold platens.

● The press specified in Methods D 15 requires steam-heated platens. The temperature is controlled by a pressure regulator on the exhaust side of the system. Thus thermocouples are not used to control the temperature but are used at intervals as a check on the performance of the pressure regulator.

If the platens are heated electrically, the need for multiple thermocouple control points would depend on how uniformly the temperature of the platens can be maintained by the heating system used and whether or not more than one heating circuit is used in each platen. Commercially available electrically heated platens with which we are familiar are not very satisfactory from the standpoint of uniformity of temperature across the platen surface. It is helpful to attach a thick aluminum plate to each platen surface; however, even with this help it has not been generally possible to meet the tolerance of ±1 F.

One well-known laboratory uses steam-heated presses to cover the range up to 350 F, with excellent temperature control, and electrically heated presses for the higher temperatures ranges, where close temperature control is usually less critical.

Coal Ash

We have been unable to find any ASTM procedures for measuring slag viscosity of coal ash. Is there any information available?

● There is probably no better reference to cite than the work of P. Nicholls and W. T. Reid of the U. S. Bureau of Mines: "Viscosity of Coal Ash Slags," *Transactions*, Am. Soc. Mechanical Engrs., 1939.

CALENDAR

March 21–30—**American Chemical Society,** St. Louis, Mo.

March 27–30—Division of Inorganic Chemistry, **American Chemical Society,** Spring Meeting, St. Louis, Mo.

April 5–7—**Institute of Environmental Sciences,** Annual Technical Meeting and Equipment Exposition, Park Sheraton Hotel, Washington, D. C.

April 9–15—**National Association of Architectural Metal Mfgs.,** Plaza Hotel, New York, N. Y.

April 10–11—**Society of Naval Architects and Marine Engineers,** Spring Meeting, Mark Hopkins Hotel, San Francisco, Calif.

April 10–12—**Inter-Society Color Council,** 30th Annual Meeting, Sheraton Hotel, Rochester, N. Y.

April 10–14—**American Society of Civil Engineers,** Phoenix Convention, Hotel Westward Ho, Phoenix, Ariz.

April 10–15—**International Institute of Welding,** Sheraton-Atlantic, New York, N. Y.

April 11–13—**American Society of Lubrication Engineers,** Annual Meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

April 12–14—First International Symposium on Agglomeration sponsored by **AIME,** Sheraton Hotel, Philadelphia, Pa.

April 17–21—**American Welding Society,** Annual Meeting and Welding Exposition, Hotel Commodore, New York, N. Y.

April 18–20—**American Institute of Electrical Engineers,** Cement Industry Conference, Sheraton-Cadillac Hotel, Detroit, Mich.

April 20–22—**Refrigeration Research Foundation,** Annual Meeting, Palm Beach, Fla.

April 22–27—**Scientific Apparatus Makers Association,** Annual Meeting, The Greenbrier, White Sulphur Springs, West Va.

April 23–27—**The American Ceramic Society,** Royal York Hotel, Toronto, Ontario, Canada.

April 23–28—**American Institute of Architects,** Bellevue-Stratford Hotel, Philadelphia, Pa.

April 24–26—**Association of Iron and Steel Engineers,** Spring Conference, Jefferson Hotel, St. Louis, Mo.

April 26–27—**AIME** Technical Conference on High-Temperature Materials, Carter Hotel, Cleveland, Ohio

April 30–May 4—**The Electrochemical Society,** Claypool Hotel, Indianapolis, Ind.

May 1–3—**American Oil Chemists' Society,** Annual Meeting, Sheraton-Jefferson Hotel, St. Louis, Mo.

May 7–10—**American Institute of Chemical Engineers,** National Meeting, Sheraton-Cleveland, Cleveland, Ohio

May 8–12—**American Foundrymen's Society** Castings Congress and Exposition, Civic Auditorium and Brooks Hall, San Francisco, Calif.

May 9–11—**AIEE-IRE-ACM Western Joint Computer Conference,** Ambassador Hotel, Los Angeles, Calif.

May 11–12—**The American Institute of Chemists,** Annual Meeting, Statler-Hilton Hotel, Washington, D. C.

May 11–13—**American Institute of Industrial Engineers,** (12th Annual National Conference and Convention), Sheraton Cadillac Hotel, Detroit, Mich.

May 14–18—**National Fire Protection Association,** Annual Meeting, Statler, Detroit, Mich.

May 15–18—**American Mining Congress** Coal Convention and Exposition, Public Auditorium, Cleveland, Ohio

May 21–23—**Construction Specifications Institute,** Annual Convention, Commodore Hotel, New York, N. Y.

May 22–24—**American Society for Quality Control,** Sheraton Hotel, Philadelphia, Pa.

May 22–26—**American Society of Tool and Manufacturing Engineers,** ASTME Tool Show and Annual Convention, New York, N. Y.

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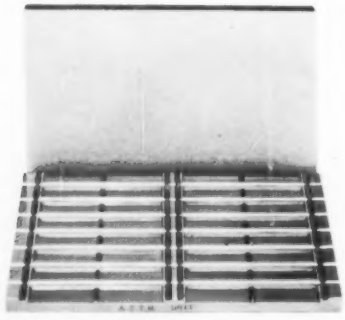

D813, Fig. 3 DeMattia, Flex Test.

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INTRODUCTION TO CERAMICS

By W. D. Kingery, *M.I.T.* A new concept in the treatment of ceramics. Rather than focussing on various divisions of the industry, it stresses phenomena, properties, and strength. This approach leads to a rational understanding of traditional ceramic compositions and novel space-age developments. NOTE: This book includes an extensive collection of micrographs, showing compositions, processing techniques, and properties. *1960. 781 pages. $15.00*

VISCOELASTIC PROPERTIES OF POLYMERS

By John D. Ferry, *Univ. of Wisconsin.* In an exacting treatment of the viscoelastic properties and behavior of polymers, the author develops phenomenological theory, followed by a wide variety of experimental methods, and a critical appraisal of their applicability to polymeric materials of different characteristics. The existing state of molecular theory is reviewed and used to interpret the effects of temperature, structure, dilution (plasticization), and other variables. *1961. 482 pages. $15.00*

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MATERIALS AND TESTING TOPICS

This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The Society is not responsible for statements advanced in this publication.

FOR THE LABORATORY

Titracolormat—A new instrument that colorimetrically determines equivalence point, automatically stops a chemical titration, and provides a digital readout of the equivalence volume of titrant has been introduced as a new tool for the research laboratory. Called the Titracolormat, the instrument performs semimicro and macro titrations when used with the Aminco-Koegel menisco-matic buret.
American Instrument Co., Inc. **3648**

Insulation Tester—The new high voltage HYPOT Model 4510 tester for both liquid and solid insulating materials has been announced. Model 4510 tests a wide range of both liquid and solid electrical insulating materials to ASTM and Federal specifications. Test potential is continuously variable from 0 to 50 kv at 2 kva ac.
Associated Research, Inc. **3649**

Miniature Thermocouples—A complete line of new HT micro-miniature thermocouples is now being offered. The high versatility, accuracy and speed of an HT micro-miniature thermocouple is due to the small size of the thermocouple wire plus a variety of hot junction configurations. Measuring 0.014 in. in diam the probe is available in several sheath materials and lengths. A response time of 13 milliseconds has been achieved with the exposed junction configuration.
Baldwin-Lima-Hamilton Corp. **3650**

Wavelength Calibrators—Wavelength calibrators for infrared spectrophotometers are being offered at no cost. A polystyrene film in one end of the calibrator may be inserted into the sample compartment of most infrared spectrophotometers. By comparing the spectral curve produced by the film with a polystyrene curve printed on the back of the calibrator, the operator is able to check the instrument for calibration, resolution, and stray light.
Beckman Scientific and Process Instruments Div. **3651**

Automotive Test Equipment—New automatic test equipment to inspect automotive components more accurately has been developed. The automatic units are claimed to eliminate the possibility of operator error, quickly performing numerous complex tests with a minimum of preparation. For example, one of the test stands automatically performs nine different tests on a power steering valve in 15 sec.
The Bendix Corp. **3652**

Recording Voltmeter—New level recorder Model 2305 is a high-speed graphic recording voltmeter for measuring the true rms, average, or peak level of a-c signals from 10 cps to 200 kcps or signals dc to 10 cps through an internal chopper. The recorder operates as a null balancing, electro-mechanical servo with six linear or logarithmic recording ranges of from 10 to 75 db.
B & K Instruments, Inc. **3653**

Convection Ovens—Especially qualified for accelerated aging tests in the electronics industry, Blue M gravity convection ovens repeatedly inject fine degree of accuracy and uniformity into test results.
Blue M Electric Co. **3654**

Water Booster—The water booster is designed to overcome the hazards of inadequate or fluctuating water pressure in laboratories where pressure is low or uneven. The water booster provides enough pressure to operate two independent and powerful aspirators at their maximum efficiency. It is noiseless in operation and needs no maintenance or replacement parts.
Buchler Instruments, Inc. **3655**

Dead-Weight Micrometer—The Cady dead-weight thickness micrometer can now be equipped with a vernier scale on end of indicator blade to permit direct readings of 0.0001 in. from the 0.001-in. dial graduations. This micrometer meets ASTM and TAPPI Standards. It has an adjusting device for setting blade at exact zero, and internal construction maintains this setting as well as keeping working parts in perfect alignment.
E. J. Cady & Co. **3656**

Vacuum Valve—A reduction of shutdown time and more positive switching action are key features of a new three-way vacuum valve now being made. Cenco's No. 94552 three-way vacuum valve is designed to be the master control in a high-vacuum system using a diffusion pump and a mechanical fore pump. It replaces the roughing, foreline, and high-vacuum valves usually assembled and built into conventional systems.
Central Scientific Co. **3657**

Environment Chamber—New environmental unit incorporates high and low temperatures—altitude and humidity—into compact 3 cu-ft chamber. Temperatures from −100 to +500 F accurately controlled to ±2 F provide a thermal capacity of 1200 Btu per hr at −100 F; pulldown from ambient to −100 F in 60 min and warmup to +500 F in 60 min.
Cincinnati Sub Zero Products **3658**

Transformers—Highly improved current transformers, available in a wide

number of ranges have been introduced. The new transformers, designated Models 605 and 607, replace the Weston Model 604 and offer many new advantages. Accuracy of the new units is such that they can be used with wattmeters as well as ammeters and conformance is to ASA C57.13 standard accuracy classes.

Daystrom, Inc. 3659

Foil Tester—A new type of ductility testing machine designed for foil and thin sheet work is now available. Called thin sheet metal and foil tester (Model TSD), the machine is designed to permit quick, accurate readings for both experimental and production work. Gripping pressure and movement of test piston of the machine may be adjusted to different levels independently of each other, so as to fit whatever test conditions are desired.

Detroit Testing Machine Co. 3660

Load Cell—This new remote-indicating load cell system permits instantaneous, direct readings of forces, in pounds, at distances over 1000 ft from the actual cell. Applications are found wherever site proximity is inconvenient, dangerous, confined or outside of naked eye range, such as a scale dial located on a crane high off the floor or a setup on a rocket test stand, etc.

W. C. Dillon & Co., Inc. 3661

X-Ray Films—The availability of the Industrial X-Ray Film, Type AA and Type M, ready pack in roll form in 16 mm, 35 mm, and 70 mm widths has been announced. As in the case of Kodak's ready pack in sheet form, the film is wrapped in a light-tight disposable envelope. The 35 mm rolls are used for the nondestructive testing of long pneumatic and hydrostatic tubes for aircraft construction. The 70 mm film is used for testing long, welded sections of thin steel and aluminum.

Eastman Kodak Co. 3662

Microscope—Designed for industrial inspection, checking and quality control, where the use of high-priced, delicate instruments is not practical, a low-cost 50× measuring microscope, with stand, is now available.

Edmund Scientific Co. 3663

Atmosphere Chamber—A compact self-contained unit, the "Vacu-Trol" Isolator/Lab, 2 ft long, 14 in. high, in which the experimenter can work with any kind of special atmosphere, or under vacuums below 2 in. of mercury is offered.

Fisher Scientific Co. 3664

Calibrating Load Cell—A new hydraulic load cell designed specifically for spot checking and re-calibrating plant and job-site testing machines and other apparatus equipped with pressure gages is available. It is said to be particularly effective for checking and calibrating large pipe testing machines.

Forney's, Inc. 3665

Ferromagnetic Separator—The separation of predominatingly ferromagnetic mixtures has always been difficult because of the tendency of the magnetic particles to attach themselves to each other forming agglomerates within which nonmagnetic particles are trapped. In a new laboratory separator for this purpose the mixture is fed down a vibrating covered chute which is inclined sideways as well as forward. An alternating magnetic field is used giving the mixture a certain amount of fluidity and allowing it to proceed down the chute.

S. G. Frantz Co., Inc. 3666

Conductivity Gas Analyzer—A new type thermal conductivity gage is announced. This instrument is suited for use as a continuous or intermittent gas analyzer and reads directly in relative thermal conductivity. It features excellent stability and repeatability. It is also available with contact meter relay control units which automatically alarm, protect, or control a system should the gas or gas mixture change beyond pre-set levels.

Hastings-Raydist, Inc. 3667

Vibration Monitors—Two new vibration monitors, Models V/p-2 and V/p-T, to be used in industry for vibration indication and protection have been designed. These completely transistorized Indikon monitors, working in conjunction with magnetic vibration pickups, incorporate several distinctive features. The a c-operated Model V/p-2 for general application offers versatility through its wide range of sensitivity. Three full vibration ranges are provided: 0 to 0.1 mils, 0 to 1.0 mils, and 0 to 10 mils.

Indikon Co. 3668

(*Continued on page 248*)

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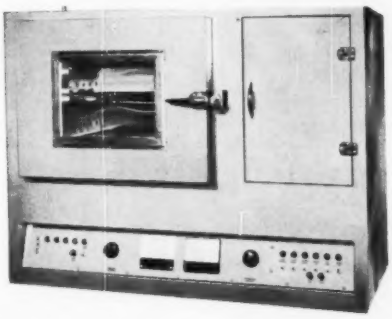
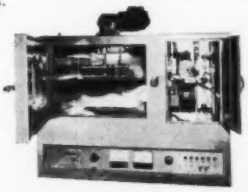


Orec 0300 Series employ an *electronic-chemical loop feed back servo system to achieve and precisely maintain chamber ozone concentrations.



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FOR FURTHER INFORMATION CIRCLE 990 ON READER SERVICE CARD

FOR THE LABORATORY

(*Continued from page 247*)

Furnace—A new furnace has been designed and constructed for special use in research and laboratories. The furnace is a small, compact furnace which heats to 2000 F in 1½ hr. A constant level of temperature and infinite heat-rate control ranging from 300 to 2300 F can be maintained by means of input controllers. These can be set from 7 to 100 per cent of input. Zone gradient control operates by multiple circuits, with each circuit having its own input controller.

L & L Manufacturing Co. 3669

Shaking Bath—The new Model 61 general purpose laboratory shaking bath is announced. It is claimed to be the largest capacity standard shaking bath available with the longest adjustable stroke. It is designed for conditions in which both continuous agitation and controlled temperatures are required. It also may be used as a standard water bath or for shaking without water.

Labline, Inc. 3670

Tables—A new series of Modulab tables is available in both wall and center table models, with great variety of sectional units and service arrangements. The new units feature advances in both utility and convenience.

Metalab Equipment Co. 3671

Air Monitor—A lead air monitor for laboratory and plant control has been developed. This monitor measures the particulate lead matter in air automatically. Samples of air are taken by drawing air through filter coupons, where the lead particulate matter is collected.

National Spectrographic Laboratories, Inc. 3672

Ultrasonic Cleaner—Both the generator and cleaning tank are housed in a one-piece polished stainless steel wrap-around cabinet in the new Model 940 ultrasonic cleaner. Minimum controls are required for operation of this 250-w unit.

National Ultrasonic Corp. 3673

Air Monitor—A commercial air monitor to effectively detect radiation in air-borne iodine vapors is offered. Called the AM-28, it is designed primarily for protection of personnel working near reactors. It detects, measures, and records the amount of specific gamma activity within the energy range of 0.33 to 0.55 Mev, and warns of any alarm condition.

Nuclear Measurements Corp. 3674

Transducer—A new d-c output variable reluctance pressure transducer for voltage controlled telemetering and other d-c systems is now available. Model CP49, the new instrument combines, in a single package, a variable reluctance pressure transducer and a d-c energized carrier-demodulator to realize both the operational simplicity of d-c output and the performance advantages of magnetic reluctance transducers.

Pace Engineering Co. 3675

Digital Multimeter—A new militarized analog to digital converter for measuring a-c and d-c voltages plus resistance, frequency, and period has been announced. Designated Model M7 multimeter, the new digital instrument was developed for use in automatic checkout applications including tests of missiles, space vehicles, radar, computers, and other complex electronic equipment.

Packard Bell Computer Corp. 3676

Sample Changer—An automatic sample changer that efficiently handles up to 30 solid radioactive samples and may be used for automatic absorption curve measurements has been announced. The changer holds planchet samples up to 30 mm in diam and 3 or 8 mm high. It can be used with a Picker proportional flow counter, geiger tubes or alpha, beta, and gamma scintillation detectors, the announcement said.

Picker X-Ray Corp. 3677

Micro Bath—A new micro-serological bath has recently been developed. Measuring only 7 in. wide, 6 in. deep, and 10 in. high, the new micro-bath requires only a fraction over ¼ sq ft of bench.

Precision Scientific Co. 3678

Power Supplies—Two new highly compact regulated power supplies have been announced. Two two units, designated Models 170 and 171 are similar in performance characteristics except for output current which is 0.25 amp in the

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Model 170 and 0.50 amp in the Model 171.

Quan-Tech Laboratories, Inc. **3679**

Nuclear Gages—A new line of nuclear gages for noncontacting thickness-density measurement and control has been announced. The basic gaging unit, called a micrometer differs from most nuclear gages in that it utilizes a highly specialized technique of scintillation detection. The detector provides a pulse of current for each radiation "particle" interacting with the detector.

Radionics, Inc. **3680**

Magnetic Core Tester—Model 1300 magnetic core tester, a high-speed, multiple output pulse generator that provides programmed, high amplitude current or voltage pulses for laboratory research and development, and for full-scale production testing of high-speed magnetic materials, solid state digital devices and computer circuits and systems is now available.

Rese Engineering, Inc. **3681**

A-C Power Regulator—Absence of power factor, instantaneous response, and smooth, proportional power regulation from 5 to 95 per cent of full power are advantages claimed for this new three-phase power regulator.

Research, Inc. **3682**

Vibrator—The Vibra-Pad is a neoprene coated, pillared table mounted on a rugged three-speed vibrator. Originally designed to accommodate a micro-sampler, this unit has proved to have a variety of applications. The arrangement of spring-holding pillars and clamping studs favors its use in vibrating laboratory setups such as small testing sieves, bubble removal, compaction and density tests, accelerating liquid-liquid separations and many other devices.

Sepor Laboratory Supply **3683**

Grinder—The problem of grinding and pulverizing some of the hardest known materials with negligible contamination has been greatly reduced by newly developed laboratory equipment incorporating a tungsten carbide vial. The carbide grinding vial with a carbide ball practically eliminates container wear when the vial is being violently shaken.

Spex Industries, Inc. **3684**

Furnaces—A new line of controlled atmosphere furnaces utilizing a unique muffle design to provide exceptionally rapid heating characteristics and long service life has been introduced. In place of the conventional wire-wound ceramic muffle, the Stewart furnaces employ the metal thermal tube itself as the heating element, acting as a resistive load across the secondary of a heavy duty transformer. The design promotes both rapid heating and quick cooling.

Stewart Engineering Corp. **3685**

Thermal Analyzer—Introduced is a thermal analyzer for thermodynamic and thermo-chemical studies of the composition and behavior of materials by differential thermal analysis, thermogravimetric analysis, pyrolysis, melting point, phase studies, kinetics and mechanisms, dilatometry, synthesis, adsorption and desorption, qualitative and quantitative analysis. The thermal analyzer consists of a vacuum-pressure inert furnace which heats a single sample or multiple samples. Materials are placed into various types of pressure-vacuum-inert sample holders that are in the furnace. A variety of temperature sensing transducers measures the temperature of sample, reaction products or holders during the analysis.

Testing Equipment Sales Co. **3686**

Torsion Balance—By dialing-in new weight loaders and fine weighing in two quick motions, accurate laboratory weight readings can be made in less than one third the usual time with a new 500-g capacity torsion balance.

The Torsion Balance Co. **3687**

NEW LITERATURE

Information Searching—An 8-page brochure describes American Society for Metals' new electronic system of searching metallurgical and related literature for specific information on subjects.

American Society for Metals **6382**

Dial Timer—New *Bulletin No. N-309* describing the new Series 309 push-button automatic reset dial timer is now available. It contains complete data on application, construction, installation, specialized functions, electrical data and

(*Continued on page 250*)

MODEL CS-90

FRL ENVIRONMENTAL TEST CHAMBER FOR ELEVATED AND REDUCED TEMPERATURE TESTING IN THE INSTRON TENSILE TESTERS

The Chamber as shown in the cut is installed from the rear in a floor model Instron Tensile Tester. The Chamber may be used with both floor and table models. At the top right of the cut is the Remote Control Cabinet for the Chamber. The standard model has a range of −90°F to +750°F and includes the hydraulic-lift dolly, control cabinet and chamber.

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- ☐ COMPRESSION SET (ASTM D-395) Compression Set Apparatus
- ☐ ENVIRON. STRESS CRACKING (ASTM D-1693) Nicking Jig, Bending Clamp, Transfer Tool
- ☐ FLAMMABILITY (ASTM D-1433) SPI Flammability Tester
- ☐ GAS TRANSMISSION (ASTM D-1434) Dow Gas Transmission Cell
- ☐ HEAT DISTORTION (ASTM D-648) Heat Distortion Tester
- ☐ IGNITION (ASTM E-136) Setchkin Self-Ignition Apparatus
- ☐ COMPRESSION AND RECOVERY (ASTM D-1147) Armstrong Indentation Machine
- ☐ RESILIENCE Nopco Ball Rebound Tester
- ☐ THERMAL CONDUCTIVITY (ASTM C-177) Alundum Guarded Hot Plate
- ☐ TORSION (ASTM D-1043) Torsion Tester

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NEW LITERATURE

(*Continued from page 249*)

basic circuit arrangements for control of up to 4 individual load circuits.
Automatic Timing & Controls, Inc. 6383

Plasma Spectrograph—A plasma research spectrograph for use in plasma diagnostics and high-temperature gas research is described in a pamphlet now available. Featuring a 15,000 line-s-per inch, 3-meter concave grating and modified eagle mounting, the B/A instrument facilitates spectrochemical analysis of plasma and permits determinations of relative spectrum line intensities.
Baird-Atomic, Inc. 6384

Density Measurement—An application data sheet aimed at clearing up some of the ambiguity surrounding the term "density" has been published. For users of Beckman's Model 930 air comparison pycnometer, the publication attempts to standardize terms by differentiating between substance density, particle density, apparent density, bulk density, surface porosity, total apparent porosity, and bulk porosity.
Beckman Scientific and Process Instruments Div. 6385

Optical Maser—A booklet describing the theory and design of the recently announced solid state optical maser is now available. The 8-page booklet, bearing a full-color cover picture of an operating maser emitting a pulse of coherent light, is a reprint of an article by A. L. Schawlow of the Laboratories' research department, which appeared originally in the Bell Laboratories record.
Bell Telephone Laboratories 6386

Automatic Programming—A new, 8-page brochure describing several of the most important automatic programming systems for the Bendix G-15 digital computer is now available. Entitled "Bendix G-15 Automatic Programming Systems," *Bulletin AR-1060* describes the general characteristics of automatic programming systems.
Bendix Computer Div. 6387

Kromo-Tog—*Bulletin No. 841* recently released, offers and describes the Burrell Kromo-Tog, Model K-7, a new ionizing instrument for gas chromatography. The 8-page bulletin presents the highlights of ionization detection in gas chromatography and explains the merits of temperature programming, an exclusive built-in feature of the instrument offered.
Burrell Corp. 6388

Vacuum Pump—Complete mechanical and operating details of the Cenco Hyvac S14 mechanical vacuum pump for industrial and laboratory applications are available in a new 14-page illustrated booklet. The S14 single-stage pump is an internal vane type with a built-in gas ballast and is recommended as an excellent backing pump for oil or mercury diffusion pumps. Operating at 750 rpm, the S14 is rated at 140 liters per min at atmospheric pressure. It is guaranteed to pump down to 10 μ of mercury. This unit's light weight and small size make it ideal as part of larger high-vacuum systems.
Central Scientific Co. 6389

Vacuum Furnaces—A 24-page *Bulletin No. 4–25* describes a full line of vacuum furnaces and accessories.
Consolidated Vacuum Corp. 6390

Laboratory Equipment—Just published is an 8-page *Bulletin No. G3-B74*, containing photographs and specifications of 44 different items. The new Denver laboratory flotation machine is described as three machines in one, being capable of performing many laboratory flotation tests in one machine that previously required three different units.
Denver Equipment Co. 6391

Flowmeter—A miniature magnetic flowmeter designed for flow rates as low as 10 cu cm per min with an accuracy of 1 per cent of full scale is fully described by *Specification Bulletin 10D1415A*. According to this bulletin, the meter, which is obstructionless, is unaffected by upstream or downstream piping configurations, viscosity, or density.
Fischer & Porter Co. 6392

Clamps—A 16-page *Catalog FS-268* describes a complete line of newly redesigned corrosion-resistant clamps, supports, and holders for industrial, educational, clinical, and testing laboratories.
Fisher Scientific Co. 6393

Lithium Chemicals—New folder, *Bulletin No. 108*, describes lithium compounds available either commercially or on an experimental basis. One of the valuable features of the folder is the inclusion of unique properties.
Foote Mineral Co. 6394

Noise Measurement—An illustrated 100-page "Handbook of Noise Measurement" covering the measurement of noise and vibration, and describing equipment requirements, procedures, and the interpretation of results, has been published. In 13 chapters, this edition offers a comprehensive survey of such topics as the decibel, man as a noise-measuring instrument, applications of sound-measurement systems, and the measurement of sound levels and sound-pressure levels.
General Radio Co. 6395

Hot Plate—A 2-page *Bulletin No. 1058* describing a complete line of laboratory hot plates has been prepared. Six different sizes of electric hot plates all incorporating "stepless control" covering the temperature range 120 F (49 C) to 950 F (500 C) are fully described.
Lindberg Engineering Co. 6396

Transistor Tester—New 4-page, 2-color bulletin describes semi-automatic component tester (SACT) for ultrareliable testing and classification of transistors according to user specifications at speeds of 30 to 60 tests per sec and resolution below a fraction of a microampere.
Monitor Systems, Inc. 6397

Combustion Bombs—Parr combustion bombs and calorimeters are listed in a new 16-page illustrated *Price List No. 61–1*

(*Continued on page 253*)

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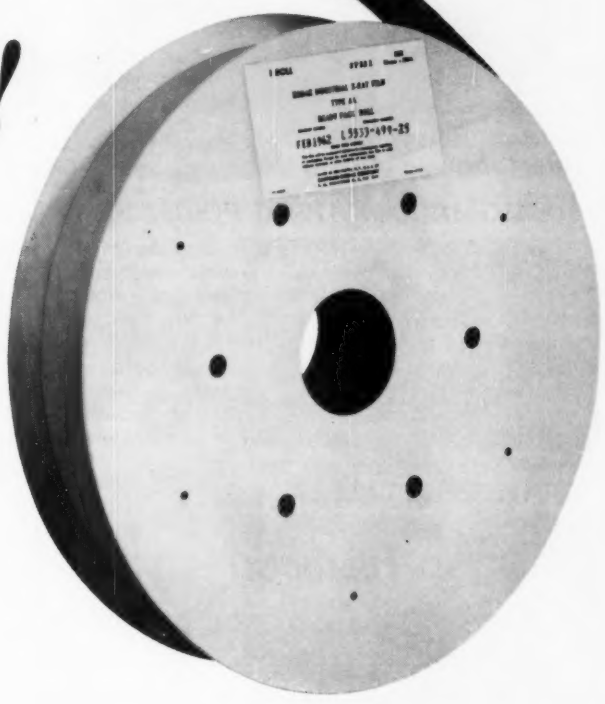

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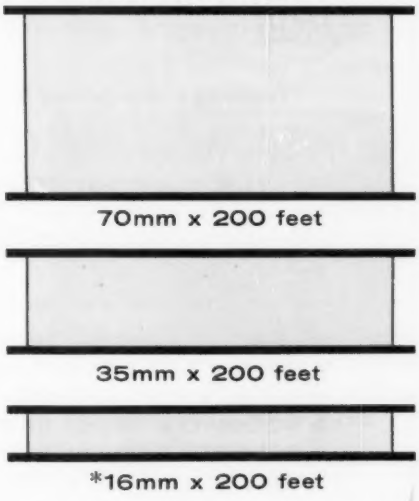

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The Development of More Stable Gage Blocks—M. R. Meyerson, T. R. Young, and W. R. Ney, National Bureau of Standards.

Laboratory Preparation of High-Purity Tricalcium Silicate—Milos Polivka, Alexander Klein, and C. H. Best, University of California.

The Identification and Determination of Natural and Manufactured Fibers—S. S. Praeger, New York Department of Labor.

A Small Panel Method for Investigating Moisture Penetration and Bond Strength of Brick Masonry—T. Ritchie, National Research Council of Canada.

The Effect of Temperature on Air Aging of Rubber Vulcanizates—M. G. Schoch, Jr., Hewitt-Robbins, Inc., and A. E. Juve, The B. F. Goodrich Research Center.

The Analysis of Stress-Rupture Data with a Minimum Deviation Function—M. J. Stutzman and J. W. Faber, Westinghouse Electric Corp.

A Study of the Centrifuge Test for Determining the Cement Content of Fresh Concrete—Stanton Walker, D. L. Bloem, R. D. Gaynor, and J. R. Wilson, National Ready Mixed Concrete Assn.

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(*Continued from page 250*)

covering complete units, component parts and accessories.
Parr Instrument Co., Inc. 6398

Soil Testers—A new 4-page bulletin on new types of laboratory equipment is available. Among the items illustrated and described are a mechanical laboratory mixer, a balanced mechanical shaker, infrared drying ovens, and mechanical mortar and pestle sets.
Soiltest, Inc. 6399

Wave Oscillators—New 6-page gatefold brochure describes with photos, specifications, and comprehensive curves on power output versus frequency and voltage versus frequency, the extensive line of backward wave oscillators. Ten BWO types are covered in the frequency ranges from 1 through 18 kmc.
Stewart Engineering Corp. 6400

Air Gaging—Complete information on air gaging is available in a new *Catalog No. 615*. The book describes air gaging principles and applications as well as the equipment available for performing these functions.
Taft-Peirce Mfg. Co. 6401

Penetration Tester—*Bulletin No. 373-ST* describing the Fotosize liquid penetration tester for sizing of paper is available. The bulletin illustrates the photoelectric fotosize tester and describes the operation of the instrument that can be operated by untrained personnel to get accurate and reproducible results.
Thwing-Albert Instrument Co. 6402

LABORATORIES

Harris Laboratories, Inc., Lincoln, Nebr.—Construction of a new office and laboratory building for Harris Laboratories, Inc., has been completed and the company has moved to this new plant. Announcement of this expansion was made by the firm's president, Lewis E. Harris.

Industrial Research and Testing, St. Louis, Mo.—Laboratories of St. Louis have announced additions to laboratory facilities and new staff personnel. The expansion permits the laboratory to undertake complete concrete testing as well as spectrochemical analysis.

MATERIALS

Solder Alloy—Technical data bulletin Z-105, describing Alloy D-800, a new high-strength, low-temperature solder alloy, is now available. Alloy D-800, as described in bulletin Z-105, is a unique solder preform material able to withstand loads at elevated temperatures without serious deformation. At 200 C the material is 80 per cent harder than normal solder alloys. The bulletin further shows that Alloy D-800 is suitable for semiconductor processing as a lead base "N" type ohmic junction material, containing neither boron nor free iron. The bulletin lists all data such as specific gravity, specific weight, compressive strength, fatigue strength, and tensile strengths and hardness at various temperatures.
Accurate Specialties Co., Inc., Hackensack, N. J.

Lubricant Coating—The characteristics of Molykote PVE, a new bonded lubricant coating for ferrous surfaces, are described in a new data sheet No. 129. Originally compounded for use on cutting tools, the new molybdenum disulfide lubricant is equally useful on heavily loaded ferrous bearing surfaces in all types of mechanisms.
The Alpha-Molykote Corp., Stamford, Conn.

Abrasives—Abrasive products for the construction trades, a new 42-page, 2-color booklet, catalogs a complete line of abrasives and related products for the masonry and concrete trade. A quick-reference reliable handbook based on more than 60 years of abrasive experience is available upon request.
The Carborundum Co., Niagara Falls, N. Y.

Ceramics—*Bulletin 121* describing the new HT-1 series of high heat- and wear-resistant ceramics is now available. Applications are listed as well as complete data on the 3 basic types available: Duramic HT-1-A, HT-1-B, and HT-1-C. The data include information such as specific gravity, softening temperature, hardness, thermal expansion coefficient, tensile strength, compressive strength, dielectric constant, power factor, and thermal conductivity.
Duramic Products, Inc., Palisades Park, N. J.

Magnetic Alloys—The development of a new line of magnetic alloys called Vapalloys which are ultrahigh-purity alloys used as source material (evaporants) to produce magnetic thin films for computer memories has been announced.
Hamilton Watch Co., The Precision Metals & Electronics, Div., Lancaster, Pa.

Adhesive—A new adhesive especially designed for bonding many types of rigid and unsupported vinyl products has been developed. Designated H-523 URA-BOND, this modified acrylonitrile rubber base cement develops a high initial bond strength that markedly increases upon aging. In addition, H-523 can be heat- or room-temperature-cured, has a long color life and can be used under a wide range of temperature and humidity conditions. When dry, H-523 remains tack-free, is oil resistant and imparts a strong, flexible bond to materials joined together. It can also be used in bonding steel, tinplate, leather, wood, glass, ceramics, and paper.
UBS Chemical Co., Cambridge, Mass.

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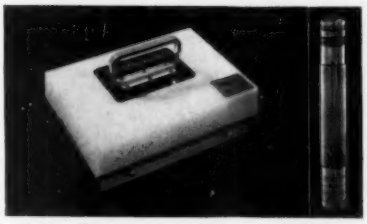
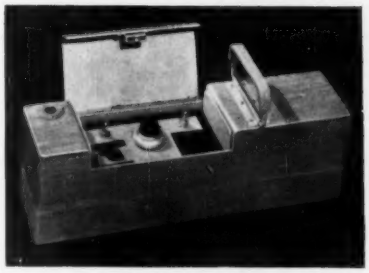


Surface Unit Depth Probe

Ra:Be SOURCE MOISTURE



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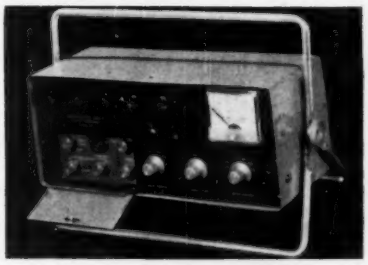

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GOVERNMENT STANDARDS CHANGES

THE FEDERAL Supply Service of the General Services Administration is charged with the responsibility for establishing specifications to be used by the Federal Government for Procurement of materials and supplies. The GSA issues an annual Index of Initiation of Federal Specifications Projects, and monthly supplements.

The following items appeared in Supplement 10 for December, 1960

PROMULGATIONS

Title	Type of Action	Symbol or Number
Cements, Hydraulic; Sampling, Inspection, and Testing	Rev.	Fed. Test Method Std. No. 158a
Identification Marking of Copper and Copper-Base Alloy Mill Products	New	Fed. Std. No. 185
Paper, Mimeograph	Rev.	Fed. Std. No. 46e
Metals, Test Methods	Chg. Not. 1	Fed. Test Method Std. 151a
Steel, Chemical Composition and Hardenability	Chg. Not. 1	Fed. Std. No. 66b
Aluminum Alloy Bar, Rod, and Wire, (Free-Machining), 2011 (Superseding QQ-A-365b)	Rev.	QQ-A-365c
Aluminum Alloy Forgings, Heat Treated (Superseding QQ-A-367d)	Rev.	QQ-A-367e
Ammonium Chloride (Sal Ammoniac), Technical (Superseding O-A-491b)	Rev.	O-A-491c
Artificial Leather, Cloth, Coated, Vinyl Resin, (Upholstery)	Am. 2	CCC-A-700b
Cardboard and Railroad Board (Manila and Wood) (Superseding UU-C-201d)	Rev.	UU-C-201e
Cloth, Cotton, Duck (Single and Plied Filling Yarns, Flat) (Superseding CCC-C-00443(GSA-FSS) and CCC-D-761)	New	CCC-C-443a
Cloth, Cotton, Percale (Superseding CCC-P-191a)	New	CCC-C-447
Cloth, Nylon Bunting and Cloth, Nylon-And-Wool Bunting	Am. 1	CCC-C-476b
Conduit, Metal, Rigid (Electrical, Aluminum) (Superseding WW-C-00540)(GSA-FSS)	New	WW-C-540a
Ethylene Glycol Monoethyl Ether, Technical (Superseding TT-E-00781a(GSA-FSS) and TT-E-781)	Rev.	TT-E-781b
Funnel, Filtering, Laboratory, Glass, Buchner Type (Superseding DD-F-00776b(HEW-PHS) and DD-F-776a)	Rev.	DD-F-776c
Funnel, Filtering, Laboratory, Porcelain, Type (Superseding DD-F-00786b(HEW-PHS) and DD-F-786a)	Rev.	DD-F-786c
Gold Leaf (Superseding QQ-G-00566b(INT-NPS)	New	QQ-G-547
Insulation Board, Thermal and Insulation Block, Thermal (Superseding LLL-F-00321b and LLL-F-321b)	New	LLL-I-535
Magnesium Alloy, Sand Castings (Superseding QQ-M-56a)	Rev.	QQ-M-56b
Mattress, Bed, Latex Foam (Superseding ZZ-M-0091b (Army-QMC) and ZZ-M-91a)	Rev.	ZZ-M-91c
Paper, Blotting (Superseding UU-P-63c)	Rev.	UU-P-63d
Paper, Bond and Writing, White and Colored (Superseding UU-P-121i)	Rev.	UU-P-121j
Paper, Book (Superseding UU-P-465c)	Rev.	UU-P-465d
Paper, Cover (Superseding UU-P-00196(GSA-FSS)	New	UU-P-196a
Paper, Duplicating, Copy, Liquid Process (Superseding UU-P-232a)	Rev.	UU-P-232b
Paper, Index (Superseding UU-P-258e)	Rev.	UU-P-258f
Paper, Ledger, Unruled (Superseding UU-P-288d)	Rev.	UU-P-288e
Paper, Manifold (Superseding UU-P-328e)	Rev.	UU-P-328f
Paper, Mimeograph (Superseding UU-P-388h)	Rev.	UU-P-388i
Plywood, Flat Panel (Superseding NN-P-530)	Rev.	NN-P-530a
Potassium Hydroxide, Technical	New	O-P-566
Steel, Sheets, Carbon, Cold-Rolled (Superseding QQ-S-00692(Navy)	Rev.	QQ-S-692b
Sweeping Compound Absorbent Material, Oil and Water	Am. 4	P-S-885a
Tag Board, Jute (Superseding UU-T-75)	UU-T-75a	
Tag Board, Manila (Superseding UU-T-78)	Rev.	UU-T-78a
Tape, Pressure-Sensitive Adhesive, Paper, Drafting (Superseding UU-T-0093b(GSA-FSS) and UU-T-93a)	Rev.	UU-T-93c
Wire, Measuring; Gear, Thread, and General Purpose (Superseding GGG-W-366)	Rev.	GGG-W-366a

INITIATIONS

Title	Type of Action	Symbol or Number	FSC Class	Assigned Agency & Preparing Activity
Paper, Mineograph	Rev.	Fed. Std. No. 46e	7530	GSA-FSS
Preservation, Packaging and Packing Materials	Chg. Not. 1	Fed. Std. No. 101a		DOD-Navy-Weps
Aluminum Alloy Bars, Rods, and Shapes, Extruded, 7075	Rev.	QQ-A-277a	9530 9540	DOD-USAF
Bandage, Absorbent, Adhesive	Rev.	DDD-B-35a	..	DOD-Navy-MMSA
Belting, Conveyor, Cotton (Solid Woven)	Rev.	JJ-B-191a	3030	PO
Box, Fiberboard	Rev.	PPP-B-636	8115	DOD-Army-QMC
Nickel Plating (Electrodeposited)	Am. 1	QQ-N-290	..	DOD-Navy-Weps
Paint, Styrene-Butadiene Copolymer Solvent Type for Exterior Masonry	New Pur. Des.	TT-2-12	8010	GSA-FSS
Paper, Carbon, Typewriter, Black	Int. Am. 1	UU-P-00158c (Army-QMC)	7530	GSA-FSS
Paperboard, Wrapping, Cushioning	Rev.	PPP-P-291	8135	DOD-Army-QMC
Perchloroethylene (Tetrachloroethylene), Technical Grade	Am. 1	O-P-191a	6810	DOD-Army-CE
Plywood, Container Grade	Rev.	NN-P-515	5530	DOD-Army-CE

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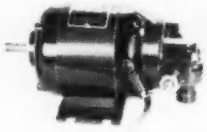

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Three papers, two by representatives of the Division of Highways and the third by a representative of the Shell Development Co., present a wealth of information and test data on the results to date from the test road. The complete progress report prepared by the Division of Highways is included in the publication. Examination of the asphalts in the Zaca-Wigmore project by means of the microfilm durability test, described in the third paper, gave ratings of relative durability to be expected of asphalts when all are used under the same conditions.

Contents:

Introduction—Bernard A. Vallerga

Progress Report on the Zaca-Wigmore Experimental Asphalt Test Project—F. N. Hveem, E. Zube, and J. Skog

Results of Cooperative Test Series on Asphalts from the Zaca-Wigmore Experimental Project—J. Skog

Correlation of the Microfilm Durability Test with Field Hardening Observed in the Zaca-Wigmore Experimental Project—W. C. Simpson, R. L. Griffin, and T. K. Miles

Influence of Chemical Composition of Asphalts on Performance, Particularly Durability—Fritz S. Rostler and Richard M. White

Effect of Temperature on the Flexibility Characteristics of Asphalt Paving Mixtures—Carl L. Monismith

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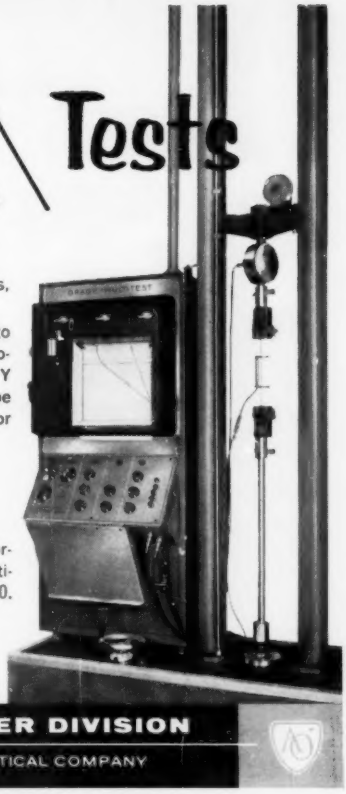

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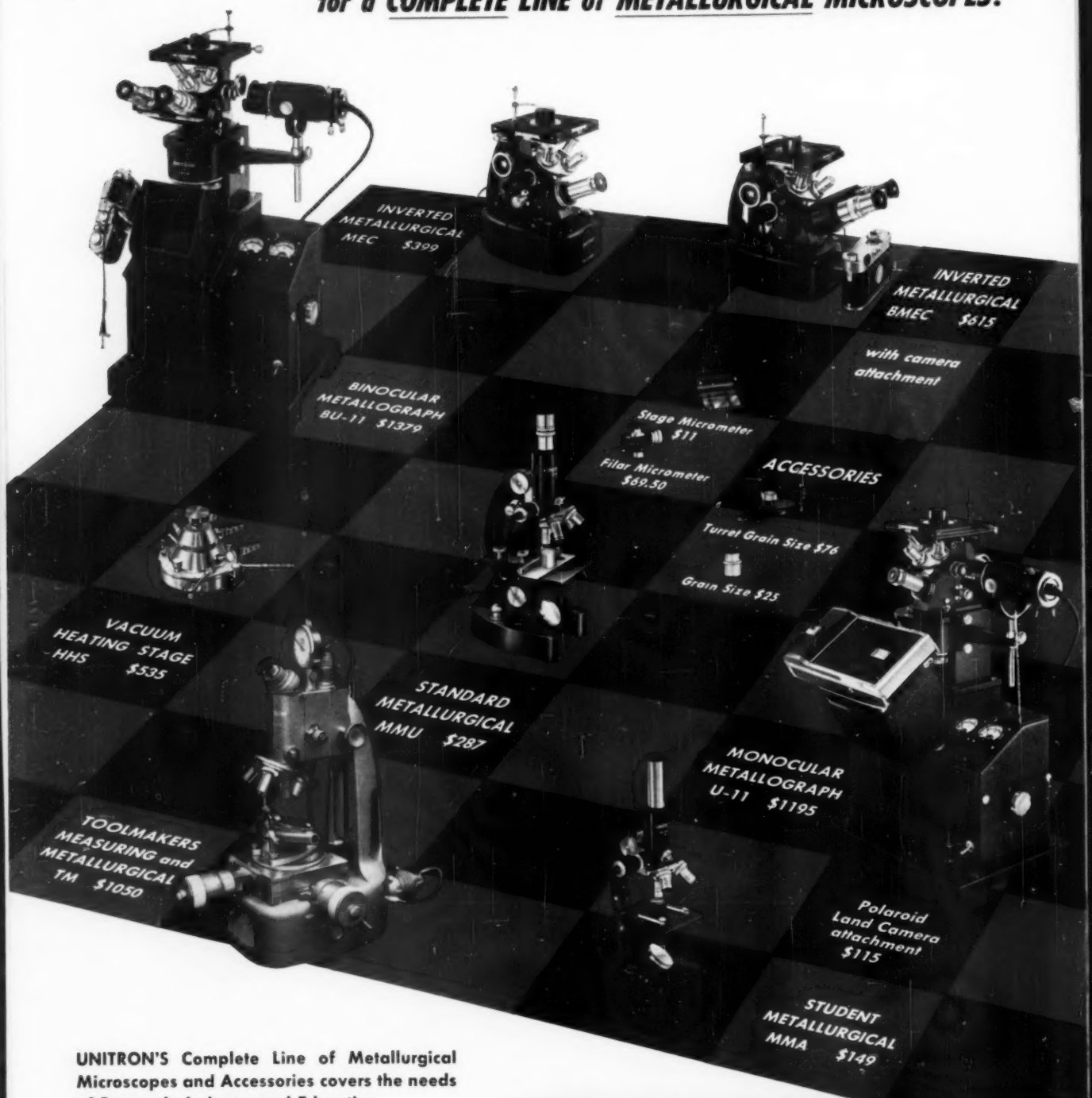

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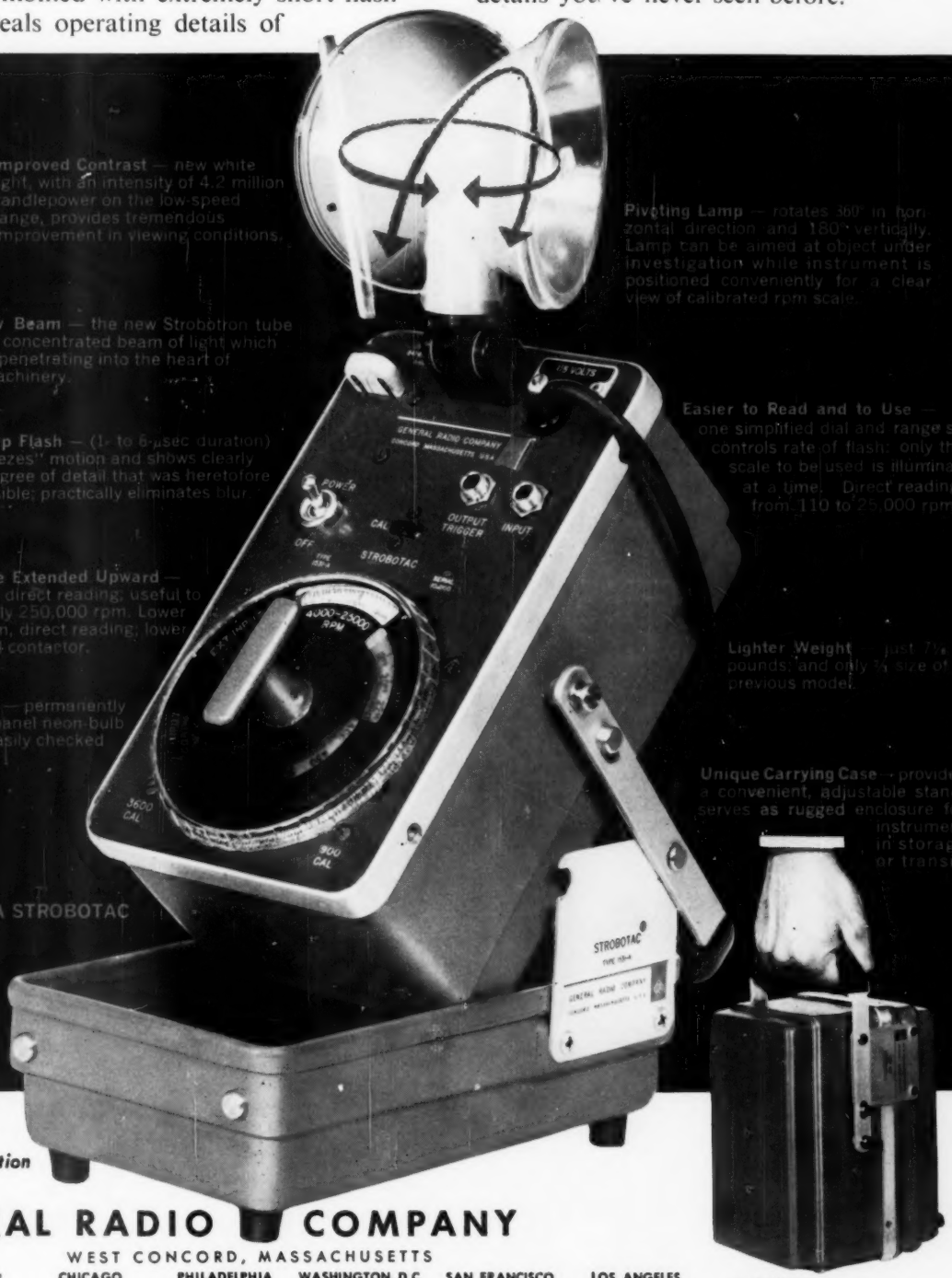

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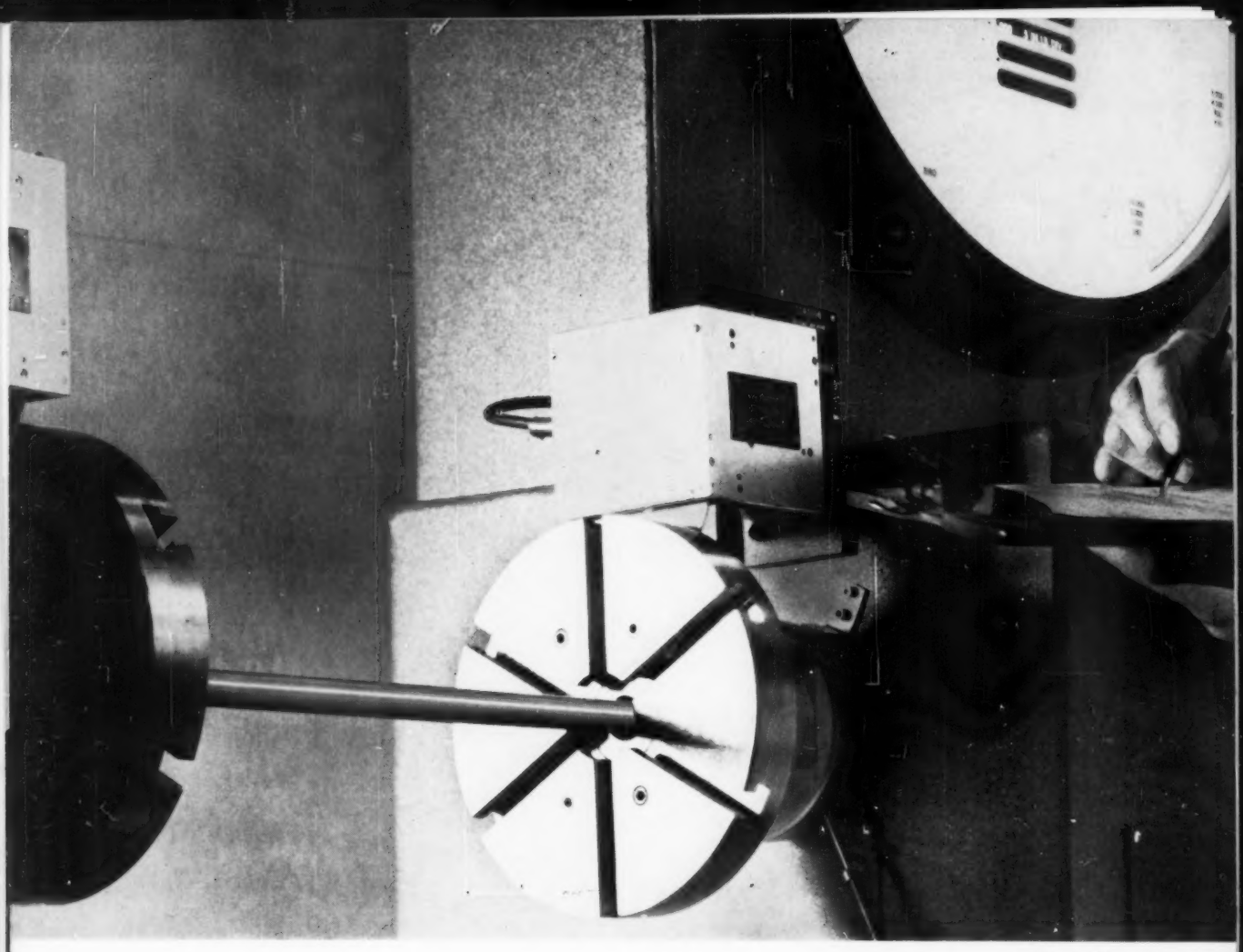

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